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Review of agri-
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1929/30 & 1930/31



Review of Agricultural Operations in India 1929-30 & 1930-31



Issued under the Authority
of
The Imperial Council of Agricultural Research

DELHI, MANAGER OF PUBLICATIONS

1933

Price Rs. 5 or 8s. 3d.



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PREFACE

After the publication of the Review of Agricultural Operations for the year 1928-29, the Imperial Council of Agricultural Research decided that the succeeding issues should be biennial. This Review, which accordingly deals with the years 1929-30 and 1930-31, is based on the annual reports from provinces and States, and the "Review of the Trade in India" for these two years. Some provincial reports deal with the agricultural year ending in June while others and the "Review of the Trade in India" deal with the fiscal year ending in March. In some instances information is included in the provincial reports for later portions of each year. These reports have appeared at various dates towards the end of 1930 and during 1931 and 1932 : the last provincial report was received in September 1932.

In this Review an attempt has been made to include all important information available during the two agricultural years 1929-30 and 1930-31, and the statistics quoted with the exception of those relating to exports and imports relate to these agricultural years.

CONTENTS

	PAGE.
CHAPTER I. AGRICULTURAL CONDITIONS OF THE YEARS 1929-30 AND 1930-31	1
1. Agricultural conditions	1
2. Economic conditions	4
3. The Imperial Council of Agricultural Research	6
 CHAPTER II. ECONOMIC WORK ON CROPS	 14
1. Rice	17
2. Wheat	34
3. Cotton	43
4. Sugarcane	60
5. Jute	73
6. Other fibres	76
7. Tobacco	79
8. Oil-seeds	83
9. Tea	90
10. Coffee	96
11. Rubber	97
12. Fruit	99
13. Fodder Crops and Grasses	107
14. Millets	116
15. Other Cereals	119
16. Potatoes	121
17. Beans and Pulses	124
 CHAPTER III. RESEARCH AND INVESTIGATION	 128
1. Soils	128
2. Soil Fertility	136
3. Nitrification	138
4. Manures and Fertilizers	142
5. Water Requirements of Crops	147
6. Agricultural Meteorology	148
7. Plant-breeding and Genetics	149
8. Plant Physiology	151

	PAGE.
CHAPTER III. RESEARCH AND INVESTIGATION— <i>contd.</i>	
9. Plant Diseases	154
10. Entomology—Insect Pests	163
11. Useful Insects	172
12. Sericulture	174
CHAPTER IV. AGRICULTURAL ENGINEERING	179
1. Hydraulics	179
2. Well boring	181
3. Lift Irrigation and Water-lifts	182
4. Improved Water-lifts for Bullock-power	183
5. Embankments and Channels	183
6. Agricultural Machinery	184
7. Mechanical Cultivation	187
8. Electricity in Farming Operations	188
CHAPTER V. LIVE-STOCK	189
1. Prevention and Treatment of Disease	189
2. Disease Control in the Provinces	192
3. Veterinary Research and Investigation	194
CHAPTER VI. 1. LIVE-STOCK BREEDING	199
Cattle-Breeding	199
Other Breeding	204
2. DAIRYING	205
3. ANIMAL NUTRITION	208
CHAPTER VII. VETERINARY EDUCATION	211
CHAPTER VIII. DISTRICT WORK	215
1. Demonstrations	216
2. Peripatetic Demonstrations	219
3. Agricultural Exhibitions	220
4. Seed Production and Distribution	221
5. Implements	224
6. Fertilizers	226
CHAPTER IX. AGRICULTURAL EDUCATION	228
1. Agricultural Colleges	228
2. Post-graduate Training in Agriculture	231

	PAGE.
CHAPTER IX. AGRICULTURAL EDUCATION— <i>contd.</i>	
3. Agricultural Schools	232
4. Rural "Bias" Schools	234
5. Short Courses	236
6. Adult Education	237
CHAPTER X. THE CO-OPERATIVE MOVEMENT AS AFFECTING AGRICULTURE	239
CHAPTER XI. PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS .	255
CHAPTER XII. RECEIPTS AND EXPENDITURE OF THE AGRICULTURAL AND VETERINARY DEPARTMENTS	257
APPENDIX I. AREAS UNDER NEW AND IMPROVED VARIETIES OF CROPS IN INDIA DURING 1929-30 AND 1930-31 .	260
" II. LIST OF AGRICULTURAL STATIONS IN INDIA IN 1929-30 AND 1930-31	266
" III. STAFFS OF PROVINCIAL AND STATE DEPARTMENTS OF AGRICULTURE IN INDIA, 1929-30 AND 1930-31	281
" IV. RESULTS OF WELL BORING DURING 1929-30 AND 1930-31	283
" V. SALE OF IMPROVED IMPLEMENTS THROUGH DEPARTMENTAL AGENCY DURING 1929-30 AND 1930-31	284
" VI. IMPROVED SEED AND MANURES DISTRIBUTED THROUGH DEPARTMENTAL AGENCY DURING 1929-30 AND 1930-31	286
" VII. DEMONSTRATION AND PROPAGANDA WORK DURING 1929-30 AND 1930-31	288
" VIII. WORKING OF AGRICULTURAL COLLEGES AND SCHOOLS DURING 1929-30 AND 1930-31	290
" IX. OPERATIONS OF NON-CREDIT AGRICULTURAL CO-OPERATIVE SOCIETIES DURING 1929-30 AND 1930-31	296
" X. WORKING OF THE VETERINARY DEPARTMENTS IN INDIA DURING 1929-30 AND 1930-31	305
" XI. WORKING OF VETERINARY COLLEGES AND SCHOOLS IN INDIA DURING 1929-30 AND 1930-31	307
" XII. BREEDING CATTLE ISSUED FROM GOVERNMENT FARMS DURING 1929-30 AND 1930-31	309
" XIII. LIST OF AGRICULTURAL PUBLICATIONS IN INDIA DURING 1929-31	310
" XIV. KEY TO THE DIAGRAMMATIC MAP OF AGRICULTURAL STATIONS	348

Review of Agricultural Operations in India, 1929-30 and 1930-31

CHAPTER I.

AGRICULTURAL CONDITIONS DURING 1929-30 AND 1930-31.

1. AGRICULTURAL CONDITIONS.

1929-30

The rainfall of the monsoon of 1929 was adequate and generally well distributed, although heavy rains in places resulted in floods causing damage to the crops as in parts of Assam, the Punjab and Sind. Averaged over the plains of India, the rainfall during the main monsoon period was in defect by one per cent. During the retreating monsoon period the rainfall was in very large excess in Bihar and Orissa, the Punjab, Sind and Bengal, and in moderate excess in Assam and the North-West Frontier Province; it was nearly normal in Bombay, the Central Provinces, Mysore and Madras but in moderate to large defect elsewhere. Taking the year as a whole, the rainfall was within 25 per cent. of the normal except in Sind, where it exceeded twice the normal amount. In Assam, the excessive rains in June caused heavy flooding in both the Brahmaputra and Surma valleys and, even though a large proportion of the rice fields was resown after the subsidence of the floods, the unfavourable season that followed caused a marked decrease in the yield. In the Punjab, though the weather conditions were generally favourable, yet in the riverine and low-lying districts crops suffered considerably from heavy

floods, and excessive rains in July and the general dry months that followed were prejudicial to the maturing of the *kharif* crops. Sind received unprecedented rainfall, causing heavy flooding and resulting in great damage to crops, life and property. In the United Provinces the monsoon was below the normal. Rains were throughout insufficient in the western districts, while in the rest of the province poor rains in September followed by a dry October marred the *kharif* harvest and delayed the *rabi* sowings. Timely showers in December, however, relieved the situation and yielded in some places a bumper harvest. But the drought in the western districts was made more acute by an unparalleled visitation of locusts which caused havoc in no less than 17 districts and extended into the Punjab and Central India. A prolonged break in the monsoon between July and September affected adversely the *kharif* crops in Khandesh, the Karnatak and some districts of the Konkan in the Bombay Presidency, also in Guntur and the central districts of the Madras Presidency. Owing to the unsatisfactory distribution of the rains, the *rabi* crops were also more or less a failure in Khandesh and the Deccan. In Burma, the rainfall was abundant but badly distributed. At first conditions were promising, but the unusual break in the monsoon from the third week of October spoilt what would have been a bumper paddy crop in Lower Burma and had a disastrous effect on the later crops in Upper Burma.

The rice crop of the year was good although the yield was 4 per cent. less than the plentiful harvest of the preceding year. After an indifferent harvest in the preceding season, the wheat crop of 1929 gave a good outturn, which was 10 per cent. higher than in 1928. The yield of sugarcane too was slightly better. The cotton and jute crops were not as favourable as in the preceding season, the yield of the former being less by 9 per cent. and that of the latter by 2 per cent. Among oil-seeds, the outturn of the groundnut crop was 23 per cent. less than the record yield of the preceding season, although it was 34 per cent. above the average yield of the preceding five years. Rape and mustard gave an increased

outturn, but sesamum and linseed gave less than in the preceding season.

1930-31

The rainfall of the monsoon of 1930 was good and fairly well distributed throughout the country, although its activity in August was confined to Burma and North-East India. Averaged over the plains of India the total rainfall of the monsoon period was in defect by 2 per cent. The retreating period of the South-West Monsoon was characterised by an excess of rainfall over the whole country except in the Punjab, North-West Frontier Province and Sind where it was in moderate or large defect; in Burma and the United Provinces in slight defect; in Bengal and Central India normal. The total rainfall of the year as a whole was within 18 per cent. of the normal. In the Punjab, the climatic conditions were generally unfavourable for the *kharif* sowings. The rainfall in August and September, though below normal, proved useful for the standing crops, but locusts, hailstorms, dry winds and insects had an adverse effect on the yields in some places. The unusually dry weather proved to be unfavourable for *rabi* sowings, but the light rains in January, February and March, though insufficient, were welcome to the standing crops. Some damage was caused by frost in December and January and by the dry winds in March and April, but conditions proved to be favourable for harvesting operations. In the Central Provinces and Berar, the weather was generally propitious for the *kharif* crops. As for *rabi*, the season proved favourable in the Nagpur and Chhattisgarh Divisions but distinctly unfavourable in the North, in the Nerbudda Valley and Berar. The season was thus favourable and almost all the principal crops showed an increased outturn. The rice harvest of the year was plentiful and exceeded the previous year's good crop by about 2 per cent. The wheat crop of 1930 was a bumper one and its production was estimated at the record figure of over 10 million tons. Sugarcane gave a good yield which was 15 per cent. higher than that of 1929-30. Another good crop of jute was obtained in 1930, surpassing the previous year's crop by 8 per cent. The oil-seed crops of the year also showed an

increase as compared with the preceding season. Cotton alone gave a reduced outturn, being 8 per cent. less than that of the preceding year.

2. ECONOMIC CONDITIONS.

The last fifteen years constituted a period of high prices of agricultural commodities. During this period remarkable progress was made in agricultural improvements through the efforts of both official and private agencies and there is no doubt that the earnings of the agriculturist increased greatly during this time, but unfortunately too little of this wealth went back into land improvements, better fed cattle and better houses and too much was spent in unproductive objects like litigation, dress and expensive food. Thus, when the period of world depression arrived, the agriculturist was not in a firm position to meet adversity. The depression, the worst experienced for very many years, started in 1929, deepened at an accelerated rate in 1930, and at the end of the period under review there was no definite indication that the bottom had been reached. In fact, during 1931-32 conditions became progressively worse. The principal causes of this world-wide depression as analysed by experts were overproduction in comparison with the normal rate of consumption, particularly in the case of raw materials; the concentration of gold in creditor countries, chiefly America and France, resulting in the depletion of reserves and consequent, deflation; and unsettled political conditions in many countries, notably India, China, Russia and South America. During the last twenty years great advance has been made not only in opening up new areas for growing crops and by increasing the efficiency of production, but also by the discovery of higher-yielding strains of plants and of means of resisting unfavourable conditions, diseases and pests. The increased production of foods and raw material has come about at a time when the demand for these products is abnormally inelastic.

One of the most important features of the depression was the phenomenal fall in prices that affected all countries alike. In order to show more clearly the fall in prices in the case of raw materials in India, the following table gives the wholesale prices of several

of them at centres where the prices are typical. It must be remembered of course that these prices are not those paid to the primary producer—such are usually much lower—but it is not possible with present knowledge to give exact figures for them. Still the prices recorded below give a clear enough concept of the disastrous fall :—

Fall in prices.

Commodities	April, 1929	October, 1929	April, 1930	October, 1930	April, 1931	Percentage decrease from April, 1929
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	
1. Wheat, white, Lyallpur, per maund.	6 5 6	4 8 0	3 6 0	2 1 9	1 14 0	70
2. Rice, Ballam No. 1, Calcutta, per maund.	6 6 0	7 4 0	6 1 0	6 2 0	4 6 0	31
3. Cotton, raw, M. G. F. G. Broach, Bombay, per candy (784 lbs.).	354 0 0	344 0 0	272 0 0	202 0 0	198 0 0	44
4. Jute, raw, Firsts, Calcutta, per bale (400 lbs.).	68 8 0	60 0 0	49 0 0	30 0 0	28 0 0	59
5. Linseed, bold, Bombay, per cwt.	10 11 0	13 13 0	12 1 0	9 4 6	7 4 0	32
6. Groundnuts, decorticated, Madras, per candy (500 lbs.).	46 0 0	53 0 0	43 0 0	30 0 0	30 0 0	35
7. Sesamum, white, bold, Bombay, per cwt.	11 11 0	11 13 0	10 4 0	9 8 0	8 6 0	28
8. Castor seed, F. A., Bombay, per cwt.	10 8 0	10 1 0	9 8 0	7 15 0	7 0 0	33
9. Tea, sale average, Calcutta, per lb.	0 10 8	0 10 11	0 8 10	0 10 7	0 6 0	43
10. Sugar, Java, whites, 25 D. S. and higher, Calcutta, per maund.	9 8 6	9 5 6	9 1 9	8 11 6	8 15 0	6

It is seen that wheat, jute, cotton and tea suffered the greatest decline in prices and then came oil-seeds and rice. In the case of sugar the fall was small and the prices subsequently rose owing

to the increased duties imposed on foreign sugar in pursuance of the protective policy initiated by Government. The immediate effect of this heavy fall in prices of agricultural produce was the reduction of the purchasing power of the rural population, which constitutes 90 per cent. of the total population, and this was reflected in the huge reduction in the imports of manufactured articles. It also led to serious maladjustments in the transactions between landowners, tenants and labourers. Landowners who borrowed money for cultivation expenses found themselves in many cases without the wherewithal to repay. Tenants and labourers found their purchasing power much reduced and this evil was accentuated by the higher standard of living fostered by the years of prosperity, though in the case of the poorer classes some alleviation was provided by the low price of those agricultural commodities which are daily necessities of life.

Adjustment must come in time, but how soon it is impossible to forecast, and there is doubtless a considerable period of trouble to be faced. The effect of this state of affairs on the work of the Agricultural Departments must inevitably be serious in the near future, although it has not yet been felt appreciably except in the curtailment of the expansion of their activities.

3. THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

Mention was made in the last Review of the establishment of the Imperial Council of Agricultural Research by the Government of India. In years to come this will be regarded as an epoch-marking event in the history of agricultural improvement in India.

The Council held its inaugural meeting in June 1929 and passed its draft Memorandum of Association and Rules and Regulations. At this meeting representatives of the provinces reported the progress made by Provincial Governments in the preparation of schemes for assisting the sugar industry and decided to set up a Sugar Committee.

In this Committee the Council has a qualified and representative body to which it can refer all questions affecting the welfare of the sugarcane industry in India. During the period under

review the Committee, which had received a general mandate from the Council to examine and report on measures necessary for the development of the sugarcane industry in India, held three meetings. One of the first recommendations was that the Government of India should be asked to institute an enquiry through the Tariff Board in regard to the question whether protection should be given to the Indian sugarcane industry. This recommendation was accepted by the Council and the latter's representations were successful in inducing the Government of India to order such an enquiry. Pending full consideration of the Tariff Board's report, the Government of India had already taken action and raised the duties on imported sugar as from the year 1931-32. The Council has also accepted all the major recommendations of this Committee, for example, the establishment of a chain of sugarcane research stations embracing all the sugar-growing provinces of India, the appointment of a technologist whose advice is in great demand by existing and prospective sugar manufacturers in India and the endowment, in collaboration with the Government of the United Provinces, of a research sugar factory at the Harcourt Butler Technological Institute, Cawnpore.

From sugar the Council turned its attention to locusts. In 1929, the northern and north-western provinces of India were subjected to one of those periodic visitations which in a short space of time wipe out in the tracts concerned a whole season's work of the agriculturist. It was realised that there was little use in trying to cope only with a locust invasion once it was in full force but that efforts should rather be directed to deal with this menace in its initial stages so that it could be overcome before the invasion became uncontrollable. The problem was first examined by the Board of Agriculture which met at Pusa in December 1929 under the auspices of the Council. Several important recommendations were made, but before they could be considered by the Council, information was received early in 1930 that a locust visitation had already commenced. The Committee, slightly enlarged, met at Delhi in February 1930 and before adjourning drew up an interim report making recommendations for the adoption of control measures

which, though they might not completely avoid, might yet reduce the ravages of this pest. The Council took immediate action on such of the recommendations as related to measures of control. With the whole-hearted co-operation of the Governments of the United Provinces and the Punjab which, warned by the experience of visitations in 1929, were already by their own efforts achieving a great measure of success in coping with the visitation of 1930, arrangements were made to have warnings of the visitation of locust swarms transmitted by telegram to the Locust Bureau which the Council established under the charge of a Locust Bureau Entomologist. These warnings were then broadcasted to all the other authorities concerned. From the first it was realised that control measures in British Indian Provinces alone were of little avail unless they were also adopted in the neighbouring Indian States and in those further away which were also victims of this visitation, and in the territories of some of whom locusts were suspected to have permanent or semi-permanent breeding grounds. His Excellency the Viceroy in his speech to the Chamber of Princes in February 1930 made an appeal to the States concerned for co-operation, and the response of the States was prompt and most encouraging. Almost every State concerned took such measures recommended by the Locust Committee as were within its means and the capacity of its revenue organisation, and the services of the Locust Bureau Entomologist of the Council were requisitioned by many States to instruct their officers in control measures. At the first meeting of the Committee the question of locust research could not be touched as the immediate need then was to formulate measures of locust control and take necessary steps to get them as widely adopted as possible, but at its meeting in May 1930 the Committee made far-reaching recommendations in regard to locust research.

Out of a total cultivated area of 260 million acres in India and Burma, there are about 82 million acres under rice. In the circumstances it was only in the fitness of things that the Council should, during this early period of its existence, pay attention to the needs of this crop. In the rice-growing provinces, especially in Madras and in Bengal, a good deal of work was being done but

there was scope for much more. At the meeting in June 1930 proposals from Assam, Bengal, Bihar and Orissa, Burma, the Central Provinces and Madras were considered by a Rice Sub-Committee of the Board and a scheme from the United Provinces was subsequently added and worked into the co-ordinated scheme. The total cost of these schemes, after they had been subjected to scrutiny by the Advisory Board, came to about Rs. 11,22,400. The Board also accepted the recommendation of the Rice Sub-Committee that the Empire Marketing Board should be invited to make a grant of half this amount. In the July meeting of the Governing Body of the Council, at which this group of schemes came up for sanction, it was decided to accept in principle the recommendations of the Advisory Board. Before, however, sanctioning detailed estimates of any individual scheme, the Governing Body desired that enquiries be made from the Empire Marketing Board as to what contribution the Board was prepared to make towards these schemes. Just before the close of the period under review intimation was received from the Empire Marketing Board offering to contribute a sum of Rs. 2,03,279, being half the cost of the Burma and Bengal schemes. The Council is therefore faced with finding a total sum of Rs. 9,19,129, but in view of the importance of rice to India, it is not unlikely that the Governing Body, which has to meet in 1931-32, may choose to find the rest of the money without calling upon the provinces to share in this expenditure.

The investigation of problems relating to the conservation of indigenous manurial resources and the development of the use of indigenous fertilizers have for some years past attracted a great deal of notice in India. They are by themselves of great inherent importance in a country like India where holdings are generally small and the capacity of the agriculturist to buy manures limited. The Council therefore appointed a Fertilizers Committee, which held its first meeting in June 1930. This meeting was an exploratory one and, apart from the recommendations made, the discussion of manurial problems by those interested was of value for the future work of the Committee. Almost every member of the

Committee undertook before the next meeting to investigate and report on some point which had emerged during the discussion. It was felt that, before it could profitably meet again, the existing data on manurial experiments carried out in the provinces in the past should be correlated and made available. For this purpose the Council sanctioned a small grant to each province but it will take some little time before existing data in regard to manurial experiments conducted in the past have been collected and correlated.

The avowed object of the Council is to enlist non-official as well as official agencies in the furtherance of agricultural research. Amongst the former the universities are the most important. Soon after the inauguration of the Council, it was made known to universities that the Council would welcome any proposals for the conduct of research bearing on agriculture in the universities. As a result two applications for grants from workers in the universities of Dacca and the Punjab were sanctioned at the very first meeting of the Council. Since then several other applications have been received and sympathetically considered during the period under review. On its Advisory Board the Council has four representatives of the universities elected by the Inter-University Board. The Provincial Research Committees, which are the provincial counterparts of the Advisory Board, have also representatives of universities on them. The collaboration of workers in the universities on committees appointed by the Council and in the journals published by it, of which mention will be made later, has been sought and is being freely given. In fact, one of the most encouraging signs in the work of the Council is the increasing co-operation which it is receiving from the Indian universities. Numbers of gentlemen unconnected with any of the departments of government have during the period under review helped the Council in an honorary capacity by serving on its committees and by contributing to its journals, and the Provincial Governments in a time of financial stringency and depleted staffs have never refused to let the Council have the benefit of the services of their officers.

Animal husbandry research which should, from its importance to a country like India where animal power is still predominantly used in the practices of agriculture, claim an equal share in the Council's activities did not do so during the period under review. For the reason for this we must go back a little. The veterinary departments in India were not as strong as the agricultural departments successfully to weather the lean financial years which followed the termination of the war. The result was that, when the Imperial Council of Agricultural Research was established towards the end of 1929, the departments concerned with animal husbandry in India were not in such a favourable position to take advantage of the financial facilities offered by the Council because they lacked co-ordination and were undermanned and immersed in the conduct of routine administration. The Imperial Institute of Veterinary Research at Muktesar suffered from a like disability, though more research than could have been reasonably expected from the very restricted and insufficiently organised staff that was available was conducted at that institution. In these circumstances it was hardly a matter for wonder that departments dealing with animal husbandry in India were not at first in a position to share with agricultural departments and the universities in the grants which flowed from the Council. At the close of the period under review this situation had considerably changed for the better. It is not too much to say that the generosity with which the Council financed schemes of agricultural research acted as a spur and an encouragement to the veterinary departments in India, and it is anticipated that progress will be more rapid as the inadequacy of the provision which has been made for animal husbandry work in the past is more fully realized. In April 1930 the animal husbandry colleague of the Agricultural Expert Adviser to the Council reached India and immediately applied himself to the task of finding out what was required to bring animal husbandry research up to a standard and extent commensurate with its value to the country. During the period under review two schemes for the appointment of research officers at the Imperial Institute of Veterinary Research, Muktesar, were sanctioned in

principle. In addition, several other far-reaching schemes were under preparation which, it is hoped, will come to fruition during the year 1931-32. The animal husbandry side of the Council's activities will, however, always lag behind the agricultural until two disadvantages from which it suffers are remedied. One is that the veterinary departments in India are greatly undermanned. Unless these departments are adequately staffed, both in regard to numbers and in the quality of their personnel, it is to be expected that suggestions for conducting research from the provinces will be few and far between. The Council is, however, doing what it can to remedy this state of affairs and it is likely that, as has been stated above, schemes for research in animal husbandry which have been under preparation during the period under review and which entail the giving of grants for the creation of disease investigation staffs in the provinces will come into effect in 1931-32. The Council's resources are, however, not so extensive, nor indeed is it its function to bring veterinary departments in India up to strength, and it is to be hoped that provinces will on their part do what they can within the limit of their means to make up this deficiency. The second disadvantage is that the existing veterinary colleges have been compelled by circumstances to accept comparatively low standards of educational and scientific training for their graduates, while facilities for animal husbandry research, which should be an important part of veterinary education, have been very inadequate at most of these colleges in the past. Requests for grants for schemes of research with an agricultural bias are coming to the Council in an ever-increasing stream from the universities but that is not so on the animal husbandry side; and in view of the long periods of time required to carry out genetical research in large, slow-breeding animals, and the heavy capital expenditure involved in establishing the comparatively large farms that are required to carry on such research on an adequate scale, it is difficult to see how universities could take up schemes which could be expected to produce results of any practical significance within the term usually set by the Council in making grants. From its very nature, there are only certain lines of animal

husbandry research which can be successfully conducted in the universities.

The Council has, during the period under review, developed its activities in the matter of dissemination of information in three directions, by providing facilities to scientific workers in India to attend Imperial and International Conferences bearing on agriculture and animal husbandry, by subscribing to Imperial and International Institutions which purvey information of value to workers in India, and by means of its three regular publications: the "Agriculture and Live-stock in India" which took the place of both the 'Agricultural Journal of India' and the 'Journal of the Central Bureau for Animal Husbandry and Dairying,' the "Indian Journal of Agricultural Science" and the "Indian Journal of Veterinary Science and Animal Husbandry." In a case where either owing to the length of the article or for other reasons publication in a special form is desired the Council publishes the work in the form of a monograph. All these publications are run on a co-operative basis. The Council has also been made responsible for the preparation and issue of the Review of Agricultural Operations which previously used to be issued by the Agricultural Adviser to the Government of India.

CHAPTER II

ECONOMIC WORK ON CROPS.

The activities of the agricultural departments are now a vital part of the agricultural life of the country and so multifarious are they that in a review like this no more is possible than to draw attention to their more conspicuous features. In this chapter reference will be made to research and development work which can most conveniently be grouped under individual crops. Varietal improvement was the first big success and this provided a useful means for securing other agricultural improvements. Once it was demonstrated that the improved varieties of, for example, wheat and sugarcane would respond to and pay for better cultivation and manuring, the way was open to a general advance towards a higher standard of farming. All improved varieties call for a better standard of cultivation if their possibilities are to be realised in full. Most will give better results than the mixtures they have replaced even without improved cultivation, while a few, especially sugarcane, demand better cultivation as a condition to success. The replacement of inferior by better varieties of crops continues to be one of the most successful lines of work. It makes the least call on the cultivators' scanty capital and is easy to demonstrate as the results are usually obvious.

The ascertained area under improved varieties of crops in 1929-30 was approximately 12.2 million acres and in 1930-31 13.5 million acres, as compared to 12 million acres in 1928-29 and 10 million acres in 1927-28. As will be seen from the data presented for individual crops, these figures by no means represent the whole extent to which improved strains have replaced older varieties. It is almost an impossible task to gauge the natural spread of a variety once it becomes popular and in several important instances it is only possible to give figures for the areas of crops produced from seed distributed by, or with the knowledge of, the provincial agricultural department. The following tables give the present position so far as it can be ascertained.

TABLE II.

*Areas under improved crops in India (in acres).**

Crop	In British India			In Indian States (so far as known)				Total	
	1928-29	1929-30	1930-31	1928-29†	1929-30	1930-31	1928-29	1929-30	1930-31
Cotton	3,836,032	3,000,014	3,109,170	127,939	187,226	300,100	3,963,971	3,188,210	3,508,336
Wheat	4,124,820	4,891,725	5,025,880	2,080	1,561	336,785	4,126,915	4,890,266	5,362,674
Rice	956,225	1,085,923	1,217,717	20,658	40,128	39,581	976,013	1,126,031	1,287,298
Jute	1,143,665	1,230,602	1,104,097	..	..	..	1,143,665	1,239,062	1,104,097
Sugarcane	483,502	760,886	1,038,043	6,208	3,621	6,489	489,890	770,507	1,084,482
Groundnuts	519,379	102,100	141,877	7,407	07,085	106,316	520,846	170,175	251,923
Millets †	146,436	164,054	155,447	200,013	193,038	133,666	347,349	357,802	280,113
Gram †	210,116	201,631	222,203	200	..	..	210,406	201,631	222,203
Potatoes †	11,881	13,131	13,275	..	..	..	11,881	13,134	13,275
Other Crops †	381,405	213,110	301,780	581	771	12,906	382,046	246,881	374,783
TOTAL	11,500,010	11,715,629	12,533,410	300,262	494,130	964,973	12,173,002	12,209,750	13,408,393

* In several important instances figures have only been supplied for areas under departmental seed, no estimate of natural spread being given.
† Not separately reported by some Provinces.

COTTON. The apparent reduction in 1929-30 is mainly due to a change in the method of reporting in Bombay which makes a reduction of some 600,000 acres of which only about 20,000 represent a real difference. In 1928-29 that Presidency had 1,036,873 acres under improved cottons of which 426,402 acres were grown from departmental seed and 610,471 acres represented the estimated natural spread. In 1929-30, the area reported as grown from departmental seed was 398,321 acres and in 1930-31 410,296 acres but no estimate of natural spread was given.

RICE. The large increase in areas under improved strains is mainly in Burma, Madras and Bengal.

JUTE. The area under improved varieties is practically stationary despite a large decrease in the total jute area.

SUGARCANE. The large increase has taken place in the United Provinces, the principal sugarcane province, and the area under improved canes was ascertained by special enquiry.

GROUNDNUTS. The apparent reduction is due to a change in the method of reporting in Bombay.

1. Rice.

On an average this crop occupies about thirty-five per cent. of the total cultivated area in India, and the following table shows the area and yield during recent years :—

—	1927-28	1928-29	1929-30	1930-31	Average for the quinquennium ending 1930-31
Area in acres . . .	78,470,000	83,275,000	80,022,000	82,428,000	80,808,000
TOTAL PRODUCTION IN TONS OF PADDY.	28,234,000	32,145,000	31,132,000	32,034,000	30,645,000

Both the area and the yield of the rice crop are considerably affected by the monsoon; the proportion of the rice area irrigated from canal and other sources varies considerably in the different provinces. The rice crop of 1929-30 was good on the whole; the reduction in area occurred mainly in Bengal, Assam and Hyderabad. The crop of 1930-31 approximated to that of 1928-29 both in area and yield, and the yield was generally satisfactory, but exports of rice and paddy during 1929-30 and 1930-31 amounted to 2,326,000 tons (7.5 per cent. of the total production) and 2,279,000 tons (7.2 per cent. of the total production), respectively, as compared to 1,816,000 tons (5.6 per cent. of total production) in 1928-29. These exports consisted almost entirely of rice 'not in the husk' which accounted for 2,298,000 and 2,254,000 tons, respectively. Of the exports, Burma accounted for 88 per cent. in each of the two years, Bengal for 5 per cent. and Madras for 4 per cent. in 1929-30 and 5 per cent. in 1930-31. Exports of Burma rice to India amounted to 1,254,000 tons in 1928-29, 1,089,000 tons in 1929-30 and 989,000 tons in 1930-31. In March 1931 the export duty on rice was reduced by one-quarter, viz., from 3 annas to 2 annas 9 pies per maund. An interesting feature of the export trade was the increase in exports to the United Kingdom from 35 000 tons in 1928-29 to 79,000 tons in 1929-30 and 114,000 tons in 1930-31;

this was largely due to propaganda carried on in Great Britain by the High Commissioner for India and the Empire Marketing Board.

Reference has been made in Chapter I to the scheme of research work on Indian rices which the Imperial Council of Agricultural Research, with the financial assistance of the Empire Marketing Board and the co-operation of the principal rice-growing provinces, has been able to inaugurate. Some of the staff for the various sections of the scheme have recently been appointed and the rest is now being recruited. Though work under this scheme falls outside the period under review, the general outlines are sufficiently important to be indicated here. Briefly, this is an attempt to co-ordinate rice research in India by providing better means for co-operation between different workers and by the provision of funds and scientific staff to undertake sections of the work which had received insufficient attention. The provinces included in the scheme are Madras, Bengal, United Provinces, Burma, Bihar and Orissa, the Central Provinces and Assam, representing in 1930-31, 93 per cent. of the total area under rice in India. In all provinces a good deal of work has been done already, some of it of broad scientific value and of much more than provincial importance, so that the present scheme aims at supplementing existing work, filling gaps and promoting the better interchange of information and material between provinces. Though the agency is provincial, the scheme is essentially of an all-India character. Important conditions attached to the grants made by the Imperial Council of Agricultural Research on this scheme are : (i) that there should be a free interchange of selected types between experimental stations and farms of adjacent tracts in different provinces, (ii) that the fullest facilities should be given to economic botanists and others working on paddy to meet each other from time to time at the various research stations, (iii) that at each research station or sub-station all definite unit species, which are isolated in the course of plant-breeding work, should be fully described, maintained and made available to workers in other parts of India, (iv) that in addition to the actual production of improved strains, each station should devote attention to the general genetics of the rice plant and to the

clearing up of obscure points in connection with the inheritance of characters, (v) that in several provinces, where the agricultural and botanical surveys of the varieties of rice are unfinished, these surveys will be completed, and (vi) that experimental work will not be confined to botanical investigations but in each province adequate attention will be given to field experiments and to the cultural and manurial aspects of the problem. With reference to the last condition, it may be remarked also that special attention is devoted to the biochemical aspect at the Central Provinces research station. Further, the Imperial Council of Agricultural Research is also separately giving financial aid to investigations in the nutrition of the rice plant at Dacca University in Bengal and the Royal Institute of Science, Bombay.

Brief mention may be made of the principal features of the various provincial sections of the scheme. In MADRAS, the successful work at the Coimbatore Paddy Research Station has already solved some of the more important problems connected with paddy cultivation in Madras. A sub-station in Ganjam district to cater for the work in Madras and Orissa is provided.

In BENGAL, the improvement of the rice crop has been the principal work of the Economic Botanist for some 22 years and a great deal has already been done. Two important types of rice, however, have not yet been adequately studied, the fine Patnoi or Patnahi rice, grown mainly in the Twenty-Four-Parganas and Sundarbans district, which constitute the Patna rice of commerce, and the rices of Western Bengal. Provision has been made for two sub-stations, each under a research officer, for the study of these rices.

In the UNITED PROVINCES, a botanical and agricultural survey of the rices of the province leading on to a preliminary classification had already been made by the Economic Botanist and some work on the development of the root-system of the rice plant had been published. A new station in Rohilkhand under the control of the Economic Botanist, United Provinces, has been provided for, where plant-breeding and physiological work will be undertaken as also cultural and manurial experiments. The immediate object will

be the production of a higher-yielding and better quality rice for the area which has recently come under irrigation from the Sarda Canal.

The BURMA portion of the scheme is of special interest in that Burma provides the bulk of the rice exported from India and also supplies an average of about one million tons annually to the rest of India. The scheme provides especially for an intensification of plant-breeding work directed to the improvement of the quality of the indigenous rices without loss of yield. Questions of preparation and marketing will receive early attention. A special paddy research station is being opened and specialists with a research staff are to be engaged.

In BIHAR AND ORISSA, the second of the rice-growing provinces in point of area, a number of quite distinct rice tracts exist, each possessing its own characteristic varieties, soils and problems. The scheme, therefore, includes a rice specialist working at a central station with a number of sub-stations in the other rice tracts. Work has already started on the scheme and includes the completion of the rice survey, the isolation and testing of pure strains, and further work on manurial and cultural requirements.

In the CENTRAL PROVINCES, a preliminary survey of the rices has already been made and heavy-yielding types brought under cultivation and some preliminary work has been carried out on the cultural and manurial requirements of the crop and on the various soils of the Central Provinces. An existing experimental farm in the principal rice tract is being raised to the status of a research station and a biochemist and a botanist with the necessary staff of assistants engaged. In this way both the varietal and environmental aspects of the problem will receive adequate attention.

In ASSAM a special study will be made of the "deep-water" varieties of rice which are of great economic importance both in that province, in Eastern Bengal and in Orissa.

Current work in the Provinces.—During the two years under review, the paddy-grower in rice provinces has felt acutely the fall in prices. In many places it is necessary to go back 30 years

or more before a parallel can be found to the low prices of 1931. As is often the case in such slump periods, the actual prices obtained by growers were even lower than market quotations would indicate. Hence all means for making paddy cultivation more efficient and thus reducing the cost of production are of unusual importance.

From 976,913 acres in 1928-29 the total area under improved varieties had risen to 1,126,051 acres in 1929-30 and 1,287,298 acres in 1930-31.

MADRAS. This Presidency has about 13·8 per cent. of the total area under rice in India and produces about 16·9 per cent. of the total Indian crop—

—	1928-29	1929-30	1930-31
Area in acres	11,019,000	11,262,000	11,678,000
Production of paddy in tons	5,197,000	5,255,000	5,376,000

A feature of the crop in Madras is the high percentage (73) of the crop which is irrigated ; the irrigated rice crop accounts for about 84 per cent. of the total irrigated area. This is an unfavourable factor with present low prices.

The area under improved rices increased from 215,931 acres in 1928-29 to 245,326 acres in 1929-30 and 292,478 acres in 1930-31. Eight strains, *viz.*, G. E. B. 24, Co. 1, Co. 2, Co. 3, Co. 4, Co. 5, Co. 6 and Co. 7, all of proved superiority, have been issued from the main rice-research station at Coimbatore and are all in keen demand. The strain G. E. B. 24 is of special interest because of its suitability to very varying conditions. In Bellary, for example, it has replaced the local rices to the extent of 60 per cent. in two taluqas. In other circles, its resistance to the stem-borer makes it valuable. A number of Tinnevely varieties of rice have been under study for some years and promising strains have now been released for district testing. At the three sub-stations of Aduturai (Tanjore and Trichinopoly districts), Maruteru (Godaveri and Kistna districts) and Pattambi (Malabar and South Kanara districts) the main consideration is the raising of pure-line seed, and marked success has been obtained by the isolation of the best types from

local mixtures. Both at Coimbatore and the sub-stations, attention has been paid to a number of practical problems in rice cultivation and manuring. In view of the fall in paddy prices and the extreme probability of local over-production of paddy in Madras, the question of profitable crops such as sugarcane, groundnut and plantains which might be grown in rotation with paddy, has been taken up. In such rotations, the choice of the most suitable variety of paddy may be of great importance. Green-leaf manuring still gives the best and the most profitable result, but a small deficit of green leaf can be made up for by the use of an equivalent quantity of nitrogen supplied as sodium nitrate. From the Aduturai Station nine types have already been released and despite all efforts to keep pace with it, the demand still outstrips the supply. Other strains are under test. At the Pattambi Station, quite a large number of strains are in various stages of trial. Several have given marked increases over the unselected material; the strains Co. 3, Co. 5 and Aduturai 2 have shown promise here. At the Maruteru Station no selected strain was yet ready for issue but as in previous years mass-selected bulk seed of local varieties was in demand. Several of the strains under test show great promise. The Coimbatore strain G. E. B. 24 has proved more resistant to stem-borers than local varieties.

The research work at Coimbatore included work directed to the production of types resistant to the 'blast' disease and the inheritance studies of several characters of economic importance. The heredity of the length of the panicle has been worked out, that of grain length is under study and also that of leaf-size. Other inheritance studies are also in progress. It has been found that the tendency to lodge and its converse are associated with two types of growth habit of the tillers. It has also been found that, though very much subject to the influence of environmental conditions, the tillering habit of a rice plant is a Mendelian character and that the inheritance can be traced out by reducing modifying influences to a minimum.

Special attention has been given to the organisation of the supply of seed of improved strains. Details are not available for all circles

but even so, 2,128 tons of seed in 1929-30 and 1,232 tons of seed in 1930-31 were issued through or by arrangement with the Department; these figures include supplies by co-operative seed farms and by individual seed-growers. Most success has been obtained by the organisation of private seed-farms under departmental supervision: an effort is made to render each area self-supporting in regard to the seed-supply of a new variety as early as possible.

In BOMBAY PRESIDENCY, the rice crop is only locally important, the average area and production being $3\frac{1}{2}$ million acres and $1\frac{1}{2}$ million tons, respectively. Since the Agricultural Departments in Bombay and Sind are now independent, work in Sind is separately discussed and what follows relates to the Presidency proper. The area and production for the past three years are shown below:—

—	1928-29	1929-30	1930-31
Area under rice Bombay Presidency proper in acres.	1,053,304	1,028,252	2,261,000
Production in tons	937,813	813,707	989,000

Research work on rice is mainly concentrated at the Karjat Rice Station, with sub-stations for local work at Ratnagiri, Kunita in Kanara district and Mugad in Dharwar district. Breeding work has mainly consisted of the selection of pure-line strains from the local varieties and the subsequent testing and multiplication of the most promising. A number of promising strains have thus been obtained suitable for the diverse conditions of the Konkan districts. During the past two years particular attention has been paid to adequately replicated yield tests. The scheme for the multiplication and supply of seed of improved strains of rice generally resembles that adopted so successfully for cotton. Seed from the departmental farms is issued to registered seed-growers (97 in 1929) for multiplication and their fields are inspected and "rogued" by departmental staff. The produce from seed-growers' fields is distributed through the taluqa development associations, seed societies, grain banks and trade agencies. The supervised seed production area was about 400 acres in 1929 and 710 acres in 1930.

In this way the Department is able to control pure seed for about 15,000 acres annually.

Manurial and cultural experiments have also been carried out. In the Kumta tract green manuring *plus* bonemeal has given successful results, as has the addition of ammophos (at 100 lbs. per acre) to the basic dressing of farm manure; calcium cyanamide has also given good results. At Karjat sulphate of ammonia continues to be profitable: the effect of continued applications on the organic matter and lime content of the soil is being studied, the preliminary result being that on the trap soils both tend to be depleted.

SIND. During recent years the area under rice in Sind has been approximately 1,180,000 acres with an annual production of about 506,650 tons. Breeding work is carried out on the Larkana Farm, and three selected strains Kangni 27, Jajai 77 and Prong 36 have been established. A seed multiplication scheme has been worked out. Many well-known varieties from Bombay and other provinces have been under observation but many appeared to possess too long a vegetative period. Ratnagiri 61, Dehra Dun Bansmati, Peshawar Bara and an acclimatised Bengal variety, now known as Bengalo, showed promise.

Hybridisation between Kangni 27 and the Karjat strain Kolamba 184 promised well, as the F_2 generation included some heavy-yielding types. The area under improved varieties was 2,353 acres in 1929-30 and 2,890 in 1930-31.

BENGAL. On the average of the last three years rice occupied 20.7 million acres in Bengal or 25.2 per cent. of the total area in India, and production is estimated at 9 million tons or 29 per cent. of the total for India.

The 1929-30 crop was somewhat below that of 1928-29 in area (20,225,000 acres as compared to 21,403,000 acres) and the yield of 8,202,000 tons, as compared to 9,684,000 tons in 1928-29 and an average of 7,892,200 tons for the five years ending 1928-29, was mediocre. In 1930-31, the area increased slightly to 20,582,000 acres and the yield (9,206,000 tons) was satisfactory. The ascertained area under improved varieties increased from 185,255 acres in 1928-

29 to 192,885 acres in 1929-30 and 223,233 acres in 1930-31. There were in 1929-30, 247 private local paddy seed-farms for the multiplication of improved strains of paddy and 240 in 1930-31. These seed-farms covering 1,200 acres provided 13,000 maunds of seed in 1930-31, of which only 1,787 maunds came from Government farms.

Research work was carried out at four centres, *viz.*, Dacca for Eastern Bengal, Chinsurah for Central and Western Bengal, Barisal for the "Balam" tract and Bankura and Suri for Western Bengal. In addition, varietal tests of selected strains were carried out at most of the district farms of the province.

In Eastern Bengal, Indrasail and Latisail continue to stand first, and careful yield trials spread over four years gave 25 per cent. more than the best local variety. Bhasamanik, a new type from Chinsurah, has done well and the hybrid C. 22×R. 22 is one of the heaviest of the early types, but the cross D×I (13) is better if quality be taken into consideration.

Eight years' results of varietal tests at Chinsurah of selected *aman* strains have given the following average results, taking unselected local Nagra as a standard: Bhasamanik 34.92 maunds per acre, Dudsar 33.97 maunds, Jhingasail 33.77 maunds, Nagra No. 68 33.70 maunds and Nagra local 29.97 maunds. Dudsar is recommended in Western Bengal instead of Indrasail, as being slightly earlier and more drought-resistant. Bhasamanik is a new strain, closely resembling Nagra. It was selected from a mixed sample of local Bhasamanik seed, collected from Hooghly district 12 years ago. In the varietal tests at Chinsurah, it has stood first five years out of eight, and has established its right to be considered the heaviest-yielding of Western Bengal selections. It is now being distributed. Jhingasail is also doing well, and a considerable demand for this paddy is springing up in Bankura district. Among *aus* selections at Chinsurah, Jhanji, a strain from Bankura, and among early *aman* selections a cross D×I (13), from Dacca, are promising. The last mentioned hybrid, which has been selected from

a cross between a strain of Daudkhani and Indrasail, has yielded more than local Nagra in the varietal tests for four consecutive years and ripens a week earlier. Work has also been commenced on the improvement of Patnai paddy of commerce, grown mainly in the Sundarbans of the 24-Parganas and Khulna, but also in Hooghly and Howrah districts. This paddy is the chief paddy milled in Calcutta mills for foreign export. In recent years the export has declined considerably and complaints are being made of deterioration both in yield and quality. Collections from all over the areas where this paddy is grown have already been made and preliminary experiments started during 1930. In connection with this work and with work on rice in Western Bengal generally, Sir Hari Sanker Pal has very generously given a donation to the Department of Rs. 7,000 for a field laboratory. At Barisal several improved strains of the local Balam rice and other salt-resistant varieties were distributed. Strains of Patnai rice are promising to be heavier yielding than the Balams. At Rajshahi and throughout the Barind tract of Northern Bengal the paddy crop was badly damaged by a fungus disease *Sclerotium oryzae*. Only early varieties were affected. In the varietal tests on the Rajshahi Farm it was noted that the departmental varieties were free from the disease and yielded a normal crop, while the local variety was badly affected and yielded a very poor crop. The average figures of yield too bear this out. The departmental selection Dudsar, which stood first, yielded 20 maunds 24 seers per acre (average of six plots), while local Gazia yielded only 5 maunds. Such was the case wherever the disease occurred and, as a consequence, a considerable demand arose for departmental seed. The Department of Agriculture, collaborating with the Collector, brought into the tract nearly 6,000 maunds of departmental seed, which was immediately taken up by cultivators, partly by purchase and partly on loan. The collection of so large a quantity (a train load) was greatly simplified by the knowledge of where successful seed farms had resulted in large scale cultivation of departmental paddy.

Heavy dressing of lime to the acid soils of Dacca produced increased yields, but due to constant washing and inundation in

these soils, the lime did not seem to be retained in sufficient amount to keep up this effect.

On the average of the last three years, rice occupied 14.2 million acres in BIHAR AND ORISSA, or 17 per cent. of the total area in India. The 1929-30 crop was a little below that of 1928-29 in area (14,229,000 acres as compared to 14,352,000 acres) but the yield of 6,011,000 tons was considerably above that of the latter, *viz.*, 5,558,000 tons. In 1930-31 the area decreased slightly to 13,927,000 acres and the yield of 5,615,000 tons was satisfactory. The area under improved varieties was estimated to be 20,250 acres in 1928-29 and 23,050 acres in 1929-30, but the estimate in 1930-31 was only 15,134 acres. There has been a marked fall from 10,494 acres in 1929-30 to 756 acres in 1930-31 in the area under improved Dahia rice in South-East Bihar, where at one time this rice covered 50,000 acres. The cultivators' complaints of short weak straw and damage to the crop by heavy October rain may not be wholly without foundation, but the real cause of the reduction in area appears to be more a lack of effort to keep the seed pure, with the result that now it is little different from the local Dahia rice. Steps, however, have been taken during the last two years to encourage cultivators to obtain pure seed from the various departmental farms. The problem of improving strains of rice in this province is particularly difficult as the various rices are not grown in homogeneous areas as in Bengal. In Chota Nagpur, in the same village may be found dry rice, early rices in the high terraces and lower down medium rice, while the main crop rice is in the lowest land where there is the best water-supply. Dahia is a medium season paddy of fairly good quality and is spreading all over the province. In Chota Nagpur the variety known as Rais is recommended for the early terraces, Kankesal and Dahia for lower terraces and Latisail for the lowest land. Dahia has been found useful in South Bihar and in South-East Bihar. For Orissa there are four Cuttack selections which have given good results. Two years' trials at Cuttack tend to show that almost any early *aman* paddy may be grown. Dahia and Cuttack No. 1 have been found to be suitable on the low-lying tracts that are submerged until late in the season.

As the seed of these two varieties is available in sufficient amounts, a great difficulty which used to be experienced during years of heavy flood has been removed.

All farms were conducting experiments on artificial and natural manures and great differences were found in the manurial requirements of the various parts of the province. Niciphos, ammophos and ammonium sulphate, *dhaincha* with superphosphate, fish manure and farmyard manure all have their place. This province is well in the van with regard to the use of artificial manures and importing firms have established complete organisations for the distribution of the commoner forms, but the fall in price during the last two years has now greatly restricted their use.

On the average of the last three years, rice occupied 12·8 million acres in BURMA or 15·6 per cent. of the total Indian acreage and the production was estimated at almost five million tons or 15·7 per cent. of the total Indian output. The area gradually increased during the last three years from 12,709,000 acres in 1928-29 to 12,861,000 acres in 1929-30 and 12,911,000 acres in 1930-31 and the yield increased in proportion from 4,894,000 tons to 4,986,000 tons and 5,073,000 tons, in the respective years. The area under improved rices increased from 323,125 acres in 1928-29 to 382,972 acres in 1929-30 and 436,804 acres in 1930-31. Apart from the major seed-farms worked by the department, grazing ground seed-farms were leased to cultivators for the multiplication of seed. During 1929-30 there were 92 of these seed-farms, comprising an area of 5,440 acres, and in 1930-31 107, covering an area of 6,570 acres. The total amount of seed distributed from both sources was 2,827 tons in 1929-30 and 3,961 tons in 1930-31. Particular attention has been given in Burma to the improvement of the rice crop and to the distribution of strains which will meet the requirements of the export trade. That this work is progressing along right lines is indicated by the favourable reports received from the Burma Chamber of Commerce on samples submitted for commercial opinion. In 1929-30 two strains from Akyab farm and six from Mudon farm were considered to be suitable for export to all markets. Attempts were also made to see whether the high grade type of rice

known as Emata could be substituted for the Ngasein and Letywezin types with a view to enabling Burma rice to find an entry into high quality markets which are now barred to it. Trials with this type of paddy, the cultivation of which was formerly confined to the Promé district, have been made in the Irrawaddy, Southern, Tenasserim and East Central circles but the reports received do not make it clear that it is proved as yet that the department can with safety recommend the substitution of this type for the previously grown Ngaseins and Letywezins. It is obvious, therefore, that caution will have to be exercised before any distribution policy on a large scale is decided on. In the meantime the staff at Hmawbi are busily engaged in getting better types of Ematas and samples of two of these have been submitted to the Trade Commissioner for India for evaluation by the experts of the Empire Marketing Board who will express an opinion on their suitability for the European market. The position of the trade in Arakan was so serious as to engage the attention of Government some three years ago. The department has now been able to get into stride in this division, concentrating its efforts mainly in the Akyab district which produces the bulk of the export paddy of Arakan. In the year 1928-29 the seed distributed amounted to six tons, increased to 72 tons in 1929-30 and to 120 tons in 1930-31, whilst it is estimated that 150 tons of departmental seed were distributed by the cultivators themselves with the result that the general quality of this year's crop showed a marked improvement. The problem, however, in Arakan is of much simpler solution than it is in the larger areas of the Irrawaddy and Pegu divisions.

Work on the improvement of the rice varieties of the province was continued at Hmawbi, Myaungmya, Akyab, Mndon and Mandalay. A considerable amount of attention was given at Hmawbi to the improvement of the Emata type as already mentioned, and to the production of varieties suitable for flooded conditions. Work at Mandalay dealt with the improvement of Upper Burma rices. A re-classification of varieties of rices in the province was undertaken. Nine new selections of Ngasein made in 1929 were tested for yield against Mandalay Ngasein C. 2104,

a variety now under distribution. Several have given higher yields and one C. 2991 was decidedly superior to all the rest. Attention was also paid to varieties of Kalagyi and Mweswai.

Work with fertilizers was carried on at all the stations, but the recent excessive fall in the price of rice has practically cancelled the profits derived from their use. The price of paddy has fallen about 50 per cent. in the last two years while the price of fertilizers has fallen only 8 per cent. In the circumstances, they cannot now be recommended to cultivators with the same certainty as in previous years. The experimental work was nevertheless continued with interesting and useful results. These are not identical at all stations. The Myaungmya station reports that the paddy soil of that area responds readily to bonemeal which yields a surplus even when the application is as low as half a cwt. per acre. This result has not been obtained at any other station. At Akyab and Mudon, at which places the rainfall is over 200 inches, significant results have not yet been obtained from the use of ammonium phosphate manures, while at Hmawbi and Mandalay increases in grain yield up to 50 per cent. have been obtained. At all stations careful estimations of the residual effect of these fertilizers were kept. Cultivation experiments have been done at some of the stations dealing with the number of transplants per acre, with the comparative advantage of broadcasting and with other matters. The results obtained at Hmawbi on the broadcasting *versus* transplanting experiments appear to indicate that broadcasting gives as good a yield as transplanting, provided fertilizers are used in both cases. The results of the Hmawbi trials indicated that the optimum seed-rate of sowing was 50 lbs. per acre and that the increased yield of 160 lbs. per acre obtained by transplanting did not pay for the cost of the operation and that better yields and return on outlay can be obtained by sowing broadcast at 50 lbs. and fertilizing with an ammonium phosphate fertilizer than by transplanting. Tests have shown that certain manures, notably potassium and ammonium sulphates, either alone or in combination with other manures, cause an increase in breakage during polishing of Ngasein rice. Similar tests on Taungdeikpan manured with diamphosphos

did not give such definite results; so further data are obviously required to show what effect fertilizers may have on the milling qualities of different varieties of rice.

On the average of the last three years the area under rice in the UNITED PROVINCES is 6.9 million acres or 8 per cent. of the total area of rice in India, and the yield was estimated at 1.4 million tons or 4.5 per cent. of the total Indian production. Several selections of high-yielding rice have been made, of which 265 maunds of pure seed were distributed in 1929-30 and about 300 maunds in 1930-31. The bulk of this went to the Sarda Canal area, the development of which depends on the success of replacing the present coarse broadcast rices by fine varieties. In order to produce a variety which will be immune to the attack of *gundhi* (*Leptoeorisa varicornis*), hybridization has been resorted to using a coarse variety called Sathi which escapes the *gundhi* on account of morphological characters.

In the CENTRAL PROVINCES the area under rice is, on the average of the last 3 years, 6.2 million acres and the yield 1.7 million tons. From 6,199,000 acres in 1928-29 the area fell to 5,854,000 acres in 1929-30 and rose again in 1930-31 to 6,721,000 acres, while the yield rose from 1,647,000 tons to 1,909,000 tons and fell again to 1,664,000 tons in the three corresponding years. The area under improved varieties steadily rose from 182,000 acres in 1928-29 to 225,000 acres in 1929-30 and to 255,000 acres in 1930-31. The actual area under improved strains is much larger than the above areas, which are only the actual areas sown by seed from organised supplies. The number of private seed-farms increased from 2,550 in 1929-30 to 2,850 in 1930-31, and the quantity of seed distributed from them was 4,400 tons and 4,610 tons in the two years. Work on seed selection has resulted in the isolation of nine new strains of some of the well established varieties such as Bhata Gurmata, Gurmata, Bhundu, Parewa, Surmata, Chinoor, Luchai and Dilibuksha and these strains have been proved to be of uniform quality and improved cropping power. A system of classification based on certain botanical characters has been introduced into which all the varieties known to exist in the province can be placed and this will facilitate

further breeding work on this crop. Such work has already yielded important results, as heavy-yielding strains of rice with coloured stems have been obtained which are easily distinguishable from the wild rices. It was formerly difficult for the rice-grower to distinguish in the early stages of growth between wild rice and the cultivated varieties, and this caused him considerable loss. Three definite hybrids combining the desired characters have been fixed and their yields thoroughly tested, with the result that the hybrids were shown to be better yielders than the parent strains. Another prevailing defect in some varieties of rice is the weak character of the straw which causes the crop to fall or lodge, and the problem of eliminating this is receiving attention. In view of the importance of the rice crop to the provinces, much more work is called for, and this will be possible in the future in the scheme of research approved by the Imperial Council of Agricultural Research.

In ASSAM the average area under rice for the last three years was 4.6 million acres or 5.5 per cent. of India's total rice area, and the yield was 1.5 million tons or about 5 per cent. of the total production. In 1929-30 there were unprecedented floods in the Surma Valley and Naugong where the autumn and winter broadcast rice and *sail* seedlings were almost totally destroyed. The area under improved varieties was 12,562 acres in 1928-29, rising to 16,826 in 1929-30 and to 18,950 in 1930-31. In 1929-30, altogether 134 tons of improved seed were distributed in the Surma Valley mainly to replace stocks in the flood-stricken area and 21 tons in the Assam Valley. As a result of work done at the two main experimental farms at Karimganj and Titabar. ten *aus*, ten *sail* and three *asra* varieties have been distributed widely. In the Surma Valley the *aus* variety Dumai 36/44 topped the list with an increase of 1,174 lbs. per acre, while the *asra* variety Sail Badal gave an increase of 869 lbs. per acre in the Surma Valley and 1,260 lbs. in the Lower Assam Valley as compared with the local varieties. At the Titabar farm sodium nitrate, bonemeal and potash as well as farmyard manure and potash gave marked higher yields, while the absence of potash from the two combinations brought down the yields to nearly half.

In MYSORE STATE the area under rice rose from 707,000 acres in 1928-29 to 721,000 acres and then to 764,000 acres in the next two years, while production rose steadily from 204,000 to 210,000 and then to 227,000 tons in the corresponding years. The area under improved varieties rose rapidly from 13,522 acres in 1928-29 to 30,908 in 1929-30 and 38,159 in 1930-31. G. E. B. 24 was the improved variety most generally grown and it continued to extend rapidly in most areas where it has been introduced. Among other varieties whose area was extended are Chintamani Sanna and Banku. Rice-breeding work centred at Nagenhalli has given most promising results. Selections from a number of local varieties have given yields much in excess of that of G. E. B. 24. while some of them have shown as high a percentage of rice to paddy and a better quality than that variety. Seed of the best of these selections was multiplied at Nagenhalli for general trial on ryots' fields during the next monsoon. Preliminary work on Mulnad rices at Marthur indicated that, in the course of one or two years, selections will be ready which will give decidedly higher yields than the varieties now grown. Important experiments on the duty of water for rice under tank irrigation were brought to a close in 1929-30. They had extended over five years and six crops. While they show that the rather wasteful application of water which ordinarily takes place gives a somewhat higher yield, they also show that a very much more economical utilization of water is possible. A supply of water more than double that of the minimum used (65.5 inches of irrigation water *plus* 14.3 inches of rainfall) increased the yield by only 9 per cent., from 1,849 lbs. to 2,032 lbs. of rice in husk. The possibility of a more economic utilization of water in places of limited supply is thus indicated.

In the PUNJAB rice is of comparatively little importance except in the south-west corner. The total area is only some 976,530 acres. A classification of the rices of the area was made and five promising strains were under yield trial.

In TRAVANCORE the area under rice was 669,275 acres of which about 1,300 acres were under improved strains. About 27,000 lbs. of improved seed were distributed annually. Valsiramundan

and Samba were the common improved rices. Jamboli, G. E. B. 24, Co. 2, Puzhuthupiratty and Panamkuruva were the best of the varieties under trial. Groundnut-cake, ammophos, bone compost, and superphosphate were all found suitable. Improved methods of cultivating rice were demonstrated at 55 centres.

In BARODA the variety known as Early Kolam is reported to be increasing in popularity and arrangements have been made to supply seed among reliable cultivators for multiplication.

2. Wheat.

On an average this crop occupies about 10 per cent. of the total area under cultivation in India. The following table shows the area and yield during recent years—

—	1927-28	1928-29	1929-30	1930-31
Area in acres	32,190,000	31,973,000	31,654,000	32,180,000
Total production in tons	7,791,000	8,591,000	10,469,000	9,305,000

The total area under wheat during 1929-30 was 31,654,000 acres, which meant a decrease of one per cent. below that reported in 1928-29. The weather was much better than in the preceding year and the total outturn for 1929-30, in spite of the smaller acreage, was a record one of 10,469,000 tons representing an increase of 20 per cent. compared with the 8,591,000 tons of the preceding year. During 1930-31 the area increased by about 1·7 per cent. to 32,180,000 acres. The season was a good one and the outturn was 9,305,000 tons, being 11 per cent. below the record figure of the previous year. From 4,126,915 acres in 1928-29 the total ascertained area under improved wheats had risen to 4,896,286 acres in 1929-30 and to 5,382,674 acres in 1930-31, representing 17·4 per cent. of the total area under wheat in India. Seventy-eight per cent. of this area under improved wheat is in the Punjab and the United Provinces. Owing to the inadequate crops of the

previous two years, India had to import wheat in order to meet her own requirements. In 1928-29, however, India exported 115,000 tons, mostly at the beginning of the year, when the crop prospects were good. In order to make up for these exports and to meet the deficit caused by the unexpected lower crop, India imported in that year 562,000 tons. The net imports then were 370,000 tons. In 1929-30 exports fell to the negligible figure of 13,000 tons. Further, India had to make up the deficit in her wheat supplies by importing 357,000 tons from abroad. In spite of the bumper crop of ten million tons in 1929-30 and the consequent large exportable surplus, the export demand in 1930-31 did not reach a very big figure though it was much larger than the previous year's very low figure. This was owing to the competition of foreign wheat in international markets. Imports into India during the year amounted to 232,000 tons. Imports on this comparatively large scale in a year when India had a bumper crop available, was a remarkable feature of the trade but it was simply a matter of price. Australian wheat could be placed in the sea port towns of India at lower prices than those which had to be paid for Indian wheat brought long distances by rail from up-country producing areas. A large quantity was imported into Calcutta, Bombay and Rangoon, and it was at last necessary for Government to intervene in order to help the wheat-growers in the country. At first a reduction in railway freight was granted to wheat consignments to Calcutta and Karachi, but as it was feared that this action would not suffice, a further step was taken by levying a duty of Rs. 40 per ton on imports of foreign wheat. This latter action was taken in March 1931, and its effects will be felt in 1931-32 as it was brought into force at the end of the period under review.

During the two years the price of wheat fell steadily with disastrous effect. In the Karachi market prices moved almost in sympathy with those in the international wheat market. In April 1929, the quotation for white wheat per candy of 656 lbs. stood at Rs. 45-8 and, with slight fluctuations, prices were almost continually on the decline till March 1931, when the price was Rs.19. Apart

from a rise in prices the amelioration of the wheat growers' lot can only come through improvement of quality and lowering the cost of production.

PUSA. The new wheats P. 111, P. 112, P. 113 and P. 114 gave high yields both at Pusa and Shahjahanpur. Of the numerous cultures of crosses between Pusa 4 and Federations and between P. 52 and Federations, grown on a field-scale, two—P. 163 of the former and P. 115 of the latter—proved to be the best in 1930-31 and were chosen for further trial. In 1929-30 the attack of rust was moderate on some varieties and was very slight on the selected ones but the weather conditions in the succeeding year were exceptionally favourable for rusts, and this afforded a good opportunity for the study of rust-resisting qualities of the various cultures under study. It is interesting to note that at Pusa orange rust (*P. tritici*) was the most serious of the rust diseases and that the selected varieties were generally resistant to this rust. At the sub-station of Karnal, however, yellow rust (*P. glumarum*) was the most serious rust disease in the year under report and both Pusa 52 and Pusa 115 were badly attacked by it, although neither of these wheats was badly rusted in Pusa. With the object of investigating the quality of some Pusa wheats grown at Pusa under dry conditions, and at Mirpurkhas under irrigation conditions, and to compare with some Sind wheats, 16 samples were sent to England for milling and baking tests. These tests were carried out by the Research Association of British Flour-Millers and a report on the results was published in the *Indian Journal of Agricultural Science*, 1, 1931. In the milling and baking tests carried out by that Association Pusa 111, a new wheat bred at the Imperial Institute of Agricultural Research, Pusa, proved equivalent in value to good Manitoba wheat, and the Association reported that if it could be successfully grown in India, it would be of commercial importance as a strong wheat. Millers need both strong and weak wheats to secure, by mixing or blending, flour of given baking properties, and two of the Pusa samples, *viz.*, the well-known Pusa 12 and Pusa 114 are reported to have high blending value and from all points of view are classed as superior

to the ordinary commercial Karachi wheat used in England for blending.

At Pusa a certain area is set apart for growing pure seed of the best varieties for distribution to departments of agriculture and private growers for renovation of stocks ; and, in 1929-30, 419 maunds were distributed and, in 1930-31, 469 maunds, the principal types being P. 4, P. 12, P. 52 and P. 111. A field-trial to test the influence of ammophos on the yield of grain and straw in wheat showed a significant increase of about 10 per cent. on each.

The PUNJAB has about 34 per cent. of the total area under wheat in India and produces 39 per cent. of the total crop. In 1928-29 the area under wheat was 11,299,000 acres, in 1929-30 it was about the same, *viz.*, 11,321,000 acres, while in 1930-31 it fell by six per cent. to 10,641,000 acres. The area under improved varieties in 1928-29 was 2,099,000 acres as compared with 2,516,600 in the next year. It declined to 2,448,000 in 1930-31 or 22 per cent. of the area under wheat in the province. Most of it is under Punjab 8A, which accounts for 2,292,400 acres. That under Punjab 11 has declined to 76,650 acres and the rest is under Pusa 4, P. 12 and others. The outturn in 1928-29 was 3,423,000 tons ; next year it was 4,208,000 tons and in 1930-31 3,560,000 tons. About 150 comparisons of 8A against a number of other varieties were carried out under irrigation conditions on farms scattered throughout the province and as usual by far the greater number of comparisons were in favour of 8A. Of the wheat crosses referred to in the previous review, four were extensively tested at Lyallpur, Gurdaspur, Montgomery, Hansi, Sirsa, Sargodha and Ludhiana. Two of them were found to be very susceptible to rust and two others, 518 and 516, were definitely better yielders than 8A. Another cross 409 has also given better outturns than 8A. Milling and baking tests showed that in yield of flour 409 and 516 were slightly superior to 8A while 518 was equal to it. In baking qualities 516 was decidedly inferior to 8A, 409 was slightly inferior and 518 was almost equal. In making *chapatis* 516 was very poor, 409 somewhat better and 518 almost as good as 8A. Punjab 8A, the standard variety, is hard to beat. The cultivators' crop of

Durum wheats grown on strong lands in Gujranwala and Sialkot are usually mixtures of the three types that have been isolated and are known as Nos. 1, 2 and 3. At Lyallpur Type No. 1 has been found to be best agriculturally, and arrangements have been made to raise the level of purity by supplying pure seed of that type. A simplified hot water treatment has been adopted and found to be efficacious against loose smut. Bunt is common in the wheat crops of the Simla hills and Kangra and Kullu valleys. Cases of 30 per cent. loss of crop owing to attacks of this disease have been frequently recorded and it is difficult to find wheat fields in these localities which are quite free from the disease. About 600 maunds in 1929-30 and 12,000 maunds in 1930-31 of pure smut-free 8A seed were supplied to farmers and it is hoped to do this annually as long as necessary.

The UNITED PROVINCES is the second largest wheat-producing province, having 22 per cent. of the wheat area in India and producing nearly one-third of the total wheat crop. In 1928-29 the area was 7,218,000 acres, in 1929-30 7,289,000 acres, an increase of one per cent., while in 1930-31 it was 7,731,000 acres, a further increase of 9.6 per cent. In 1928-29 the yield was 2,500,000 tons, in 1929-30 3,342,000 tons and in 1930-31 2,725,000 tons. The area under improved varieties rose from 1,390,000 acres in the previous year to 1,600,000 and 1,800,000 acres in the two years under review. The chief varieties that are in popular favour are Pusa 12 and Pusa 4, the latter being very much appreciated on account of its rust-resistant character. Pusa 54 is also gaining popularity, because, being a bearded wheat, it is less liable to attack by birds. Other successful varieties are Cawnpore 13, Muzaffarnagar, and Pusa 52.

The CENTRAL PROVINCES AND BERAR is the third important wheat-growing province, having an acreage of about 11 per cent. of the total area in India. In 1928-29 the area sown was 3,310,000 acres but in 1929-30 it fell to 3,098,000 acres after the calamitous rust year and in 1930-31 it rose again to 3,129,000 acres. The yield in the first year mentioned was only 541,000 tons, while in the two years under report it was 617,000 and 641,000 tons. The area

under improved wheats was 8 per cent. of the whole area under wheat in the province in 1928-29, and in the last two years rose to 11 and then 12 per cent, respectively. The chief problems associated with the improvement of this crop are concerned with the production of rust-resistant and high-yielding forms for the main wheat tracts of the north of the province and of rapid maturing types of hard wheat for the southern wheat plain. Considerable progress has been made in these directions and quite new forms are now awaiting field-trial and multiplication. The mass selection of Hawra continues to give good results and the individual selection No. 12 has maintained its reputation. It is, however, becoming quite clear that at present the selection from commonly grown forms is not likely to be particularly effective in securing wheats of higher value to the grower. The problem of improving the crop, therefore, resolves itself into finding better ready-made forms or evolving them by hybridization. Both methods are being tried. Exotic forms have so far not done sufficiently well to merit introduction, but hybrids resulting from the crossing of these with local wheats are under observation and certain fixed crosses have given, on small-scale trials, indications of promise. Of wheat varieties tested, P. 100 is still the best under irrigation and Pissi for the ordinary condition of dry cultivation. Interesting results have been obtained in a study of the root-system of the wheats of the province and there was a considerable difference in the depths to which the roots penetrated in the years 1929 and 1930. This character appears to be associated with the power to resist drought and is obviously of considerable importance in a country where wheat is grown both under conditions of natural rainfall and under irrigation. In the previous two years rust and frost affected the wheat crop adversely and in 1929-30 damage was done by the early cessation of the monsoon and, in the tracts most affected, by the absence of later winter rains. Fortunately, however, the season 1930-31 was favourable both in respect of monsoon and freedom from rust. In the autumn of 1929, the Revenue Department placed Rs. 5 lakhs at the disposal of the Department of Agriculture to make good local deficiencies, and this allowed the purchase of seed from areas in which

the better varieties were established and its distribution in areas not so sown in the past. The area under improved seed from seed-farms and reliable sources under the departmental control was 355,057 acres, an increase of 31 per cent. over the previous year. It was not to be expected, however, that this rapid increase following the calamity of 1928-29 would be continued, but in 1930-31 there was still an increase of 6 per cent. over the previous year.

In BOMBAY the area under wheat was 2,503,000 acres in 1928-29, 2,469,000 acres in 1929-30 and 2,810,000 acres in 1930-31. The outturn in 1928-29 was 499,000 tons, next year 546,000 tons, which is 9 per cent. greater though the area was 1 per cent. less, and in 1930-31, 587,000 tons. Estimates of the total area under improved varieties is not available, though the departmental farms sold seed enough in 1929-30 to sow 11,260 acres.

Breeding work is carried on by the Crop Botanist at Poona, pending the opening of a special wheat-breeding station at Niphad in the Nasik district, where about one-quarter of the total wheat crop in the Presidency proper is grown. The Bansi variety of wheat has received special attention but the improved yielding strains so far evolved appear to be susceptible to rust. District trials indicate that strain No. 809 will prove suitable for Nasik and Nagar. The grain of this wheat is lustrous, the yield is high and it is relatively rust-resistant. Strain No. 103 has not lived up to its promise. An early strain No. 168 and also No. 224 appear to be suitable for West and East Khandesh, respectively. Similarly the latter strain should be the standard wheat for North Gujarat where its character of earliness is appreciated. Efforts to obtain rust-resistant strains have resulted in the selection of these strains and hybridization has been adopted with a view to obtaining rust-resistant wheats having the good qualities of Bansi. The chief improved variety on irrigated areas is Pusa 4, which is popular because of its rust-resisting character. Every year a fresh supply is obtained from Pusa to keep up the quality on the seed-farms, and from these, in the second year under report, 41,000 lbs. of seed was distributed by the Co-operative Department in the eastern areas.

In SIND, the area under wheat was 408,821 acres in 1928-29, 676,813 acres in 1929-30 and 575,000 acres in 1930-31. The out-turn in 1928-29 was 82,092 tons, in 1929-30 198,538 tons and 156,000 tons in 1930-31. Botanical work on the improvement of the wheat crop in Sind is now concentrated at Sakrand for irrigated wheats, and at Jacobabad for unirrigated wheats. The original and main line of work, as in the improvement of most crops in India, has been by selection from existing varieties of the crop in Sind. The final selected varieties obtained are C. Ph. 47 (selected Phandani), A. T. 38 (selected Thoree, from North Sind) and G. S. 25 (selected Boojri, from Lower and East Sind). All these selected varieties give at least 20 per cent. greater outturn than the ordinary Sind wheat crops from which they have been evolved. The two first-named are awnless and the latter is an awned variety. In addition to improvement of the local varieties by selection, different varieties of wheats from other parts of India and from other wheat-growing countries of the world, *e.g.*, Australia, Canada and the United States of America, have been imported into Sind for the purpose of acclimatization and adoption. The best known and most important of these importations are the famous Pusa wheats. The variety Pusa 12 is already well established among the wheat-growers of North Sind, and other high quality Pusa wheats, notably Pusa 4, Pusa 52, Pusa 111 and Pusa 114, appear to be well suited to Sind conditions. Other successful importations include Punjab 8A and Punjab 11, two valuable wheats from the Punjab, Manitoba No. 1, the world-famous strong wheat of Canada, and Bina wheat from the North-West Frontier Province. Experimental work carried out in previous years had indicated that, as a general rule, the selected strains of Sind wheats, *viz.*, C. Ph. 47, A. T. 38 and G. S. 25, were higher yielders than any of the imported varieties although certain of the Pusa types, notably Pusa 12, approached them very closely in this respect. During the *rabi* season of 1930-31, a series of wheat varietal tests were carried out throughout Sind in order to obtain the fullest information with regard to the yields of the improved varieties under trial in district conditions. In all twenty-nine centres were utilized for these

tests, nine under unirrigated conditions and twenty under irrigated conditions. The main conclusions drawn from this series of tests are as follows:—With regard to “Bosi” wheats A. T. 38 is the highest-yielding wheat under “Bosi” conditions in North Sind, C. Ph. 47 standing next. Under these conditions Pusa 12 is definitely low-yielding. In Lower Sind, C. Ph. 47 variety gives the best outturn, and among awned wheats, Punjab 8A and Punjab 11 are both superior to G. S. 25.

With regard to irrigated wheats, C. Ph. 47 is the highest-yielding in North and Central Sind. In East Sind, C. Ph. 47, Punjab 8A and A. T. 38 are approximately equal in this respect. Pusa 12 and Pusa 114 are not far behind C. Ph. 47 in point of yield under irrigated conditions in Central Sind. Although further work must throw additional light upon the results obtained from this series of tests, the data obtained therefrom in the past season will be of the utmost assistance to the agricultural department in fixing a definite policy for the extension of improved wheat varieties in the Barrage areas.

In BIHAR AND ORISSA, the area has remained practically stationary for the three years but the yield was poor in 1930-31, *viz.*, 454,000 tons from 1,213,000 acres. The area under improved varieties has increased from 5,198 acres in 1928-29 to 23,206 acres in 1930-31. Pusa 52 is the most popular variety and is extending both on irrigated and unirrigated land in all the wheat-growing tracts of the province but, as in some years it is liable to severe attacks of rust, it cannot be regarded as an ideal wheat. Some of the new selections made at Pusa are being tried and of these Pusa 112 and 113 are at present the most likely to prove suitable. Pusa 80-5 also is being grown to some extent in North Bihar.

In the NORTH-WEST FRONTIER PROVINCE, the area was the same in 1929-30 as in the previous year, *viz.*, 1,057,000 acres, but in 1930-31 it fell to 890,000 acres. The yield in 1928-29 was 231,000 tons, in 1929-30 248,000 tons and in 1930-31 216,000 tons. There were about 330,000 acres under improved varieties. Pusa 4 continued to be the most commonly cultivated variety on fertile irrigated lands and Federation on the richest single crop lands. Continued

trials at Tarnab have shown that irrigated wheat is generally most profitable after maize. A new sample of Federation wheat imported from Australia proved to be more severely infected by rust than almost any wheat that has been tested at Tarnab for the last twenty years. On the other hand, the old type of Federation grown on neighbouring land was entirely free from rust. The occurrence is of interest and seed of the old and the new Federation has been sent to New South Wales to be grown for comparison. Pusa 4 grown in the North-West Frontier Province gained the first prize in the milling and baking tests of world wheats carried out by the Department of Agriculture, United States of America.

In GWALIOR the area under wheat was 1,021,000 acres in 1928-29, 943,000 acres in 1929-30 and 1,127,000 acres in 1930-31, *i.e.*, 3.5 per cent. of the wheat area in India. The object of the Botanical Section has been to select high-yielding varieties by comparing the yield of promising wheats, with Ekdania as control. G. D. 9, G. D. 10, G. D. 11, G. D. 15 and G. C. 2 were tried. The average of the first four years tends to prove that G. C. 2 is still the highest yielder. In Durum wheats G. D. 11 and G. D. 15 are good yielders and therefore recommended for further distribution.

In PATIALA, the State Agricultural Department distributed seed of Maharaja wheat. It is the highest yielder, both in grain and *bhusa*, the bran is comparatively much less than in other wheats, is less liable to attack by weevil while in store and fetches a higher price in the market. In 1930-31 the area under the Maharaja wheat in Mansa and Dhuri Circle (5 tehsils) was 45,960 acres.

3. Cotton.

As a consequence of the unfavourable prices obtained for Indian cotton during the preceding seasons, the area under cotton in India fell from 27,053,000 acres in 1928-29 to 25,692,000 acres in 1929-30, a decrease of 5 per cent. ; and again in 1930-31 to 23,616,000 acres—a further decline of 8 per cent. The ascertained area under improved varieties fell from 3,836,052 acres in 1928-29 to 3,000,914 acres in 1929-30 and then rose to 3,809,647 acres in 1930-31. The total

estimated yield for 1928-29 was 5,811,000 bales (of 400 lbs.), for 1929-30, 5,260,000 bales and for 1930-31, 4,820,000 bales. The first of the two seasons under review was on the whole fair and the second good, the average yield per acre being 79 lbs. and 82 lbs. respectively. The number of bales pressed in 1928-29 was 5,039,000, as compared with 5,240,000 in 1929-30 and 4,904,859 in 1930-31. If to this were added the unpressed cotton received direct by the mills and the cotton used for domestic purposes, the actual crop of each season would be raised by about a million bales above the forecasted crop. The year 1929-30 was remarkable in several respects. In common with all commodities the price of cotton fell precipitously during the year, the fall in the price of Indian cotton being relatively greater than the fall in the price of American. In consequence, Indian cotton was comparatively cheaper than American during a greater part of the year and the heavy export off-take, which marked the previous season, continued throughout the season under review, the total exports for the season being 3,863,000 bales as against 3,933,000 bales of the previous season. More important, however, was the increased consumption of Indian cotton both in India and abroad which reached 6,087,000 bales, a figure which is more than the highest ever reached before by over half a million bales. Unlike the preceding season the price of Indian cotton during 1930-31 was relatively higher than that of American, and this caused a reduction in exports to 3,729,000 bales. For the same reason the world's consumption of Indian cotton fell to 5,860,000 bales in 1930-31. The number of bales of Indian cotton taken up by Indian mills also decreased to 2,269,359 bales, due chiefly to the scarcity of the better types of Indian cotton during the season.

THE INDIAN CENTRAL COTTON COMMITTEE, which was constituted in 1921 as an advisory body and later incorporated under the Indian Cotton Cess Act of 1923 with funds of its own, continued to devote attention to the work of the improvement and development of cotton-growing, marketing and manufacture of cotton in India. Though all branches of the cotton industry are represented on the Committee, the interests of the millions of cotton-growers of this

country have been its foremost consideration and every research scheme sanctioned and all legislation recommended have had the good of the grower in view. From its very inception the Committee was convinced that improvements in the quality of cotton through scientific research would benefit the grower only if the abuses in the methods of marketing against which he was helpless were at the same time checked. Recourse to legislation was therefore necessary. The Indian Cotton Transport Act, the Indian Cotton Ginning and Pressing Factories Act, the Bombay Cotton Markets Act and such other enactments in British India and similar measures in the Indian States have all had their inspiration and the strongest support from the Committee. A brief summary of the work so far done by the Committee and the nature and scope of the further work on hand has been recently published as a brochure entitled "The Present Position of the Research Schemes financed by the Indian Central Cotton Committee".

The Cotton Transport Act, which was passed by the Government of India in 1923, enables local governments to prohibit the import of inferior cotton, for purposes of mixing and substitution, into areas where superior cotton is grown. The local governments of Bombay, Madras and the Central Provinces have protected under this Act areas growing some of the very best cottons in India. The Indian States of Baroda, Rajpipla, Chhota Udepur, Sangli, Hyderabad and Indore have likewise introduced legislation on similar lines to protect tracts growing better varieties of cotton. In the BOMBAY PRESIDENCY, three zones in the Surat tract, and three in the Kumpta-Dharwar tract were notified in August 1923. A seventh zone, known as the "Narbada-Mahi Zone" was notified in 1931. The Act has worked satisfactorily in these areas and has been responsible for rehabilitating the reputation of the cottons coming from them. The question whether 1027 A. L. F. or 1 A. cotton is more paying to the cultivator in the Surat area still continues to engage the attention of the Committee. Opinion on this point is sharply divided and the Committee wishes to consider all possible data bearing on the problem, before giving an opinion on such an important question.

In 1925, the Cotton Transport Act was applied to three areas in the Madras Presidency, *viz.*, the Tirupur-Cambodia area, the Tinnevely area and the Northern and Western area. In September 1928, in deference to the wishes of the trade, the Government of Madras amalgamated the first two areas. The effect, as anticipated, was far from being in the best interests of the growers of better type cottons in this area. The Committee is keeping a watchful eye on the effect of the amalgamation.

Since there is at present no restriction on the movement of cotton by road and river, it is reported that inferior cotton from Mysore was brought by merchants first to Hosur by cart and from there by rail to Tirupur to mix with Cambodia. Considerable quantities of cotton from the Hyderabad State were also brought to Adoni and Kurnool by road and river and Pulichi cotton seed was imported into parts of Ramnad and Tinnevely for sowing.

In February 1930, the Government of the Central Provinces duly notified under the Act an area comprising the districts of Buldana, Akola, Amraoti, Yeotmal, Wardha, Chanda, Nagpur, Chhindwara, Seoni and Bhandara, where the better types of Oomra cottons are grown. This should be of some assistance in the marketing of the newly introduced improved Verum cotton and should free it from the danger of being mixed with inferior types from outside the tract.

Similar legislation has also been put into force in some of the Indian States. In Baroda, the three areas protected in 1923 under the State Act to correspond with the Gujarat Zones were maintained without change. In the Rajpipla and the Chhota Udepur States, legislation on the lines of the Cotton Transport Act continued to work satisfactorily. These two States have further made it compulsory that no variety other than 1027 A. L. F. should be grown within their territories. Hyderabad State notified the Kumpta area of the State, in the south of the Raichur district, as a protected area under the State Cotton Cultivation and Transport Act of 1929. The Hyderabad Gaorani area was also extended to the north to include the Hadgoan Taluka. The Indore State Cotton Transport Bill to which reference was made in the last year's Review has now passed

into law, and the area growing the valuable Malwa cotton has been notified under the Act. To keep out the inferior cotton of the Sholapur district from the State territories, the Sangli Durbar adopted in July 1930 similar measures to those of the Bombay Government in regard to the Kumpta-Dharwar protected area.

Six years have now passed since the Cotton Ginning and Pressing Factories Act came into force. The Act worked smoothly during the period and the few cases of infringement were reported to the authorities concerned. As stated in previous reviews, the most remarkable feature of this piece of legislation is the unstinted support it has received from the Indian States, large and small. Legislation on the lines of the Act in British India is now in force in 58 Indian States.

Reference has been made in previous reviews to the investigations carried out by the Committee into the finance of the cotton crop up-country and its marketing and to the recommendations made by the Committee to local government upon the reports of these investigations. The Central Provinces Government have amended the rules under the Berar Cotton and Grain Markets Law to rectify the defects pointed out by the Committee. The Punjab report has been translated into Urdu and published. The enquiry into market practices is still in progress.

Primary cotton markets. Further progress has been made in this matter also. The Hyderabad Agricultural Markets Bill was passed into law, and the Rules under the Act have come into force. The Rules under the Bombay Cotton Markets Act have now been finally adopted and, as requested by the Committee, are being translated into the local vernaculars. In the Holkar State a regulated cotton market has been established in Indore city. Reference has been made in the previous paragraph to the steps taken by the Madras and the Central Provinces Governments regarding legislation.

Marketing of Improved Varieties of cotton. As in previous year, the Committee continued to keep the trade posted with the progress made by the agricultural departments in the introduction of improved varieties of cotton through the medium of the *Technological Reports on Standard Indian Cottons*, and by means of the note

on the subject contributed to the Bombay Cotton Annual. Through the courtesy of the East Indian Cotton Association it was possible to complete the set of replicas of their official standards sent to the Manchester Cotton Association. Bombay standards for Sind and Punjab cotton, tenderable under Fully-Good, Machine-ginned Bengals contract, and Punjab-American cotton tenderable under Fully-Good, Machine-ginned Broach contract, are now available at Manchester to any one interested in these cottons.

Means to prevent the introduction of foreign cotton pests. The Committee continued to control the fumigation of American cotton at Bombay. During the season 1929-30 the imports of American cotton amounted to 12,759 bales compared with 10,942 bales in 1928-29. For reasons stated in a previous paragraph the imports of American cotton during 1930-31 were high amounting to 128,845 bales. In consequence of the savings effected in dealing with a large quantity, it was possible to recommend a rebate of fumigation fees at the rate of 8 annas per bale on all cotton fumigated during the financial year 1930-31. During the second year under review a reduction was also made in the fumigation charges on round or half bales. As a result of the recommendations made by the Committee in 1927, the Government of India have now prohibited the import of cotton seed by sea for any purpose other than experimental and that too, only by certain officers especially empowered in this behalf.

Cotton Statistics. The Committee continued to compile and publish monthly statements relating to the consumption of Indian raw cotton in mills in British India and in Indian States, the quantity of loose cotton received direct into mills in British India and a weekly statement regarding the purchases and import of American cotton. Since April 1930, a consolidated monthly statement showing the total consumption of Indian raw cotton in British India and Indian States during the month and since the commencement of the season, with corresponding figures for the previous season, is also being released for publication in the press. Further improvement in the consumption statistics compiled by the Committee has been made possible by all the Indian States and Pondicherry agreeing to supply

to the Committee monthly statements showing the actual quantity of raw cotton consumed in the mills situated in their respective territories.

Cotton Research. The efforts of the Committee to improve the marketing of Indian cotton, thus ensuring better returns to the grower, have been referred to in previous paragraphs. The Committee's work does not, however, stop there. From the time it was provided with cess funds the Committee has initiated schemes for the improvement of the quality and yield of the crop in different parts of the country, the study of the pests and diseases of cotton and how to check or prevent them as well as fundamental research into the cotton plant. These research schemes have cost over Rs. 40 lakhs during the last eight years. Of this amount over Rs. 14 lakhs represent the expenditure incurred on technological research, while about Rs. 24 lakhs have been spent on agricultural research. The latter sum comprises over Rs. 14 lakhs spent on the various research schemes financed by the Committee in the Provinces and the Indian States, the balance being the cost to the Committee of the Institute of Plant Industry at Indore.

Technological Laboratory. At the outset of its work the Committee realised that a properly equipped laboratory, where the fibre properties and spinning qualities of newly evolved strains of cotton could be determined at an early stage in the evolution of the strain, was indispensable. A technological laboratory was therefore established in 1924 at Matunga, Bombay. That its services in this respect are appreciated by the plant-breeders is evident from the increasing number of samples sent for test. From 46 in 1924-25 the number of samples rose to 212 in 1930-31. In addition to this, tests on standard Indian cottons were carried out. These tests are all related to the one fundamental problem, viz., the determination of the quality or intrinsic value of a cotton as distinct from its market value. The results were published in the *Technological Reports on Standard Indian Cotton, 1930*. Special tests were also carried out during the year on Banilla and Karunganni cottons to determine the extent of the alleged gradual deterioration in spinning value in the former, and to ascertain how adulteration with Pulichai cotton

affects the spinning capacity of the latter. The results obtained confirm the suspicions previously entertained. Further tests will be carried out next season and the results published. During recent years the Laboratory has been carrying out work which is of direct benefit to the trade and the mill industry and there is every prospect of further development in this direction. During 1930-31, 27 samples representing the average commercial crop as selected by the Standards Committee of the East India Cotton Association, and 21 samples of the first arrivals of the season of different cottons supplied by the Millowners' Association of Ahmedabad and Bombay were tested and their results published in "Technological Circulars" Nos. 35 to 58. Observations on the variations in the weight of cotton bales of different trade descriptions, and a thorough investigation into the normal moisture-content of bales are being conducted at the Cotton Exchange, Sewri, under the auspices of the East Indian Cotton Association. Of greater immediate importance to the Indian mill industry is the series of spinning tests begun at the Laboratory on Indian staple cottons combed to different degrees. Preliminary results show that Punjab-American 289 F. cotton combed to the extent of 20 per cent. spins 60s and a 30 per cent. combed sample spins 80s as against 44s of an uncombed sample. With the increasing demand by Indian mills for staple cottons of finer counts, much of which is at present imported, the results of these tests should be of great value. Similar tests on Cambodia, Nandyal 14, and 1027 A. L. F. are now being done. The main work of the research side of the Laboratory is to try and correlate fibre properties with spinning value. Considerable progress has already been achieved. The results of this branch of work are published from time to time in the *Journal of the Textile Institute*.

THE INDORE INSTITUTE OF PLANT INDUSTRY was started in 1924 mainly as a central research institute for cotton. The programme of work includes fundamental research into cotton as well as investigations into the general agricultural problems connected with cotton-growing on the black soils of Central India. Up to date attention has been concentrated on the latter part of the programme. Improved methods of cultivation, crop-rotation and the manu-

facture of a cheap compost manure, the making of which is within the means of every cultivator, have been worked out and brought into practice. The adoption of these methods has trebled the yield of cotton at the Institute. In order to bring these results to the notice of the growers for incorporation into general agricultural practice, annual meetings are held to which large numbers of cultivators are invited. Training is also given to *kamlars* and to revenue officials in the methods employed at the Institute and in this way it is hoped to spread the improved methods by means of men trained in the work.

In addition to the Central Research Institute at Indore, the Committee is at present financing 15 schemes for the betterment of Indian cotton. Six of these schemes are connected with the selection and breeding of new varieties of cotton for the more important tracts in India while 3 deal with physiological, 4 with entomological and 2 with mycological problems, two more schemes have been sanctioned, one to investigate the Punjab white fly and the other with root-rot in Baroda. The following is the list of the schemes and each will be dealt with in its appropriate place as the work of each Province and State is being considered :—

Botanical.

- (1) The Madras Herbaceum Scheme.
- (2) The Punjab Botanical Research Scheme.
- (3) The Khandesh Cotton-breeding Scheme.
- (4) The Hyderabad Botanical Scheme.
- (5) The Gang Canal Botanical Scheme.
- (6) The Burma Cotton Improvement Scheme.

Mycological.

- (1) The C. P. and Berar Botanical (wilt-resisting) Scheme.
- (2) The Dharwar Wilt-Scheme.
- (3) The Baroda root-rot Scheme.

Physiological.

- (1) The Madras Pempheris and Physiological Scheme.
- (2) The Surat Physiological Scheme.
- (3) The Sind Physiological Scheme.
- (4) The Madras Fodder Cholan Scheme.

Entomological.

- (1) The U. P. Entomological Scheme.
- (2) The Punjab Entomological Scheme.
- (3) The Surat Entomological Scheme.
- (4) The Madras Pempheris and Physiological Scheme.
- (5) The Punjab White Fly Scheme.

In the BOMBAY PRESIDENCY breeding work is in progress at five centres, namely, Surat, Broach, Viramgam, Dhulia, and Dharwar. Reference has been made in previous reviews to the promising type of cotton known as Surat 5 which, obtained as a result of the work at Surat, appeared to be superior to 1027 A. L. F. in all respects except in the opening of bolls. In 1930-31, however, it proved disappointing by giving weak yarns when spun in spite of its superior fibre properties. The object of the breeding work at Broach is to evolve a wilt-resistant long staple cotton with a ginning percentage equal to that of the local variety, and now several crosses are under observation. At Viramgam in the Dholleras tract, the most promising cotton so far evolved is the strain known as Wagad 8, obtained by straight selection from the local Wagad cotton. At Dhulia in the Khandesh tract in 1926 the Indian Central Cotton Committee provided funds to give a thorough test to some Bani-Comilla crosses which had been in the hands of the Agricultural Department for many years. One of these, since named Banilla, gives a similar yield, a higher ginning outturn, and produces a better lint than the local N. R. cotton. It was at first suitable for spinning 20s counts but gradually it has deteriorated; till now it is adjudged suitable for 13s only. In spite of this, however, the seed of this type is in great demand among the cultivators as it is still more profitable than the local N. R. cotton.

With the object of determining the cause of the large amount of shedding of buds, flowers and bolls and to devise measures to reduce some at least of the loss, the Indian Central Cotton Committee provided funds in 1923 to start an investigation at Surat. Very interesting results regarding the causes of the heavy losses have been obtained, but it has not been possible to suggest any remedial measures for rain-fed areas. The shedding of buds, flowers, and bolls is due to the competition between different parts of the plant for the available plant food, mostly nitrogen, at the time when the heavy flush of flowers appears. The application of a quick-acting nitrogenous manure late in the season helps a larger proportion of flowers to ripen into bolls if suitable soil moisture conditions prevail, but this is feasible only where the moisture-content of the soil can be controlled and not under rain-fed conditions as in Surat. Boll-shedding has been found to be hereditary to a certain extent and plant-breeding methods could be employed to overcome this tendency. From the results of an investigation since 1923 of the spotted bollworms (*Earias fabia* and *insulana*) which cause enormous loss in the cotton crop of these tracts, it has been proved that the only practical method of prevention is to maintain a "close" period, and a scheme to extirpate the pest from an area of 480 square miles has been worked out. It consists of an intensive cleaning up, immediately after harvest, of all cotton stalks and stubble and alternative host plants. It is hoped to launch this scheme as soon as the conditions in Gujarat permit of its receiving the co-operation of all concerned. As a preliminary, the Committee sanctioned a grant for propaganda in the area, to educate the public on the value of maintaining a "close period" between two crops of cotton. At Dharwar in the Kumpta-Dharwar tract where attention has been paid to the breeding of wilt-resistant types, the Agricultural Department is distributing a type known as Jayawant which is wilt-resistant and is at the same time as good in lint qualities as Dharwar 1, the existing improved variety, which, however, is susceptible to the disease. Further work with other wilt-resisting types is also in progress. One of the chief activities of the Department in Bombay is to organize the seed-supply

of improved types of cotton. An important development which took place during the period under review was the decision of the Indian Central Cotton Committee to subsidize work of this character. Substantial subsidies were accordingly granted for the extension and distribution of seed of Jayawant, Gadag 1, Dharwar 1, Dharwar 1 × Rosea and 1027 A. L. F. in the different tracts for which these cottons are suitable. In all about 5 million pounds of seed were handled in these schemes. In addition, the Department made their own arrangements for the distribution of N. R. and Banilla seeds in Khandesh and 27 W. N. and 4-F seeds in Sind, the total weight handled being about 7 lakhs of pounds.

In SIND attention was concentrated on the investigation of certain problems connected with the water requirements, sowing dates and the general physiology of the cotton plant under perennial irrigation in anticipation of the change from inundation to perennial irrigation under the Lloyd Barrage. Experiments already carried out with different varieties of cotton show that it would be much better to concentrate on the hardy indigenous types rather than on exotics.

Considerable work had been done on the cotton of the CENTRAL PROVINCES before the Indian Central Cotton Committee in 1923 agreed to finance a scheme for obtaining a wilt-resistant, better-yielding cotton for the Central Provinces and Berar tract, so that results have already become available. Verum 262, the type now being released for general cultivation, is a most desirable cotton. It spins 20s to 22s against the ordinary Berar's 8s to 12s and fetches a good premium on Broach. The seed of this type is in great demand among the cultivators. The Local Government in 1928-29 gave a loan of Rs. 50,000, which was increased to two lakhs in 1929-30 and to 4.5 lakhs in 1930-31, to the Department to help to market the crop and to ensure an adequate supply of pure seed, and in 1930-31 the Indian Central Cotton Committee gave a grant of Rs. 4,000 for additional staff for this purpose. It is anticipated that the whole area of cotton in the Central Provinces and Berar amounting to about 5 million acres will soon be brought under this new type, and on a modest estimate each acre is expected to yield

an extra profit of Rs. 10 to the grower. Further selection work has also been in progress with a view to obtain types suitable for the eastern portion of the Provinces and for the Northern and Plateau districts for which Verum 262 is unsuitable on account of late rains and early frosts respectively. This has also been successful. Another part of this scheme consisted of an investigation into and a remedy for the low yields of cotton in Berar and a suitable rotation, with groundnut as one of the crops, has been worked out which adds considerably to the yield of the cotton crop. The Mycological Section continued its physiological studies on cotton *fusaria*. Though the study has not been completed, the tentative conclusion arrived at is in line with the results of the experiments in Egypt, viz., that the *fusaria* responsible for wilting in Dharwar, Egypt, America and the Central Provinces are all different from one another. The seedling blight of cotton has for some time past been under study. Further observations made during the year show that the causal organism is chiefly a species of *Rhizoctonia*. An unusual phenomenon the Department was called upon to investigate during last season was the dying of mature cotton plants in Berar. Texas Root-rot was suspected to be the cause, but the American authorities to whom specimens were sent did not find any trace of this disease. It was, therefore, thought that the unequal rainfall distribution during the season might have caused this trouble. The investigation into the pink bollworm problem was continued at Akola. It was noticed that the seed of the last picking harboured more hibernating bollworms than that of earlier pickings. The treatment recommended to control this pest is to expose the seed in thin layers to the heat of the sun during May.

In HYDERABAD STATE every effort is being made to improve the quality and quantity of the cottons grown there. In 1929 a scheme financed by the Indian Central Cotton Committee was started with a view to producing a type which will be as good as Gaorani in its lint qualities and as profitable to the grower as Roseum. Considerable progress has been made in these two years and a number of selections are under observation. A great effort was made by the Department of Agriculture to oust the existing types,

by distributing seed of Gaorani, Gadag, 1, Dharwar 1 and Verum 262 in areas suitable for these types. It is estimated that in 1930-31 about 115,000 acres have been sown with seed distributed by the Department.

At Lyallpur in the PUNJAB, the study of the problems connected with cotton-growing in the Canal Colonies was continued. Investigations into the causes of the "failure" of American cotton in the Punjab show that it is mainly pathological, induced by the unfavourable climatic conditions during the period of growth of the plant. It appears that the best way of overcoming this difficulty is to produce a type of plant resistant to the harmful effects of these adverse conditions. Pending the distribution of any new strains evolved, the roguing of commercial crops on the farms of certain large estates is being carried out on a large scale in order to produce a nucleus of pure seed for distribution. Until last season it appeared that the Cotton Research Botanist had obtained a type known as Early Strain which was not susceptible to the adverse conditions which cause the "failures" and which was in every other respect a most desirable cotton, but a severe attack of Jassids during the season 1930-31 revealed the fact that this type was susceptible to Jassid attack. It therefore became necessary to concentrate attention on Jassid-resisting types, of which fortunately material is available, and work on these is now in progress which with the help of a grant recently made by the Indian Central Cotton Committee will be prosecuted with diligence as the successful solving of these problems is of inestimable importance to the Punjab. A scheme was started in 1926 to ascertain the cause of the difference in the incidence of the pink bollworm in the South-East Punjab, where it is serious, and the Canal Colonies, where it is negligible. The conclusions arrived at are that the source of infestation is, as in the United Provinces, the seed and that the difference in the incidence is chiefly due to the difference in the temperatures of the two tracts. It was found that at temperatures of 40° C and above the longevity of moths, oviposition and hatching are considerably restricted, and that caterpillars hibernating in seed can be killed by exposing the seed in thin layers to the heat of the sun during the months of

April and May. This is a simple and practical method of control within the means of every cultivator. In addition, observations on the bionomics and alternative food-plants of the spotted boll-worm during the year under report showed that the flower-buds and fruits of *bhindi* and hollyhocks attracted a large number of these insects throughout the fruiting season. The results of sowing-date experiments in previous years had favoured late sowing, but during the year under report late-sown cotton suffered most from Jassid attack. The results of further manurial experiments on the effect of applying a quick-acting nitrogenous manure at a late period in the plant's development show agreement with the observations made at Surat that a top dressing of ammonium sulphate about the end of August is really paying.

At Koilpatti in MADRAS a superior strain of Karunganni and at Guntur a good strain of Cocanadas have been isolated and are now on trial under cultivators' conditions. The problem at Nandyal is to combine the superior lint qualities of N-14 with larger yield, but so far not much success has attended the attempt. Further trials on Avanashi on ryots' lands confirm previous observations that early sowing of Cambodia cotton produces a heavier yield. At Coimbatore the effort to evolve by cross-breeding a type of cotton as hardy as Uppain (*G. herbaceum*) and as good in staple as Karunganni (*G. indicum*) must necessarily take some years to produce results. The area of cotton that will be benefited is about 800,000 acres and the tract is notorious for its light and precarious rainfall. The Pempheres and Physiological scheme has been held in abeyance for some time for lack of trained staff; but two officers from the Madras Agriculture Department are to be sent to England for the necessary training, and preliminary work has been commenced under the supervision of the Cotton Specialist, Coimbatore, pending the return of the two officers. The scheme consists of two parts, one to try methods of combating the cotton stem borer (*Pempheres affinis*) and the other to investigate the reasons why the borer prefers certain varieties to others. Another physiological scheme financed by the Indian Central Cotton Committee was started in 1930 to investigate the cause of the poor yield of cotton when grown in rotation with

fodder *chulam* (*Andropogon Sorghum*) a phenomenon which does not occur when *cumbu* (*Pennisetum typhoideum*) is the alternative crop. A grant was made by the Indian Central Cotton Committee for the distribution of Cambodia cotton seed.

In the UNITED PROVINCES the introduction of superior varieties of cotton with a view to meet the demand of the local mills has for long been the object of the Agriculture Department. In consultation with the Upper India Chamber of Commerce, the Department has decided to concentrate on the two varieties known as C. 402 and C. 520. The former is distinctly superior to Bengal, being about $\frac{7}{8}$ " in staple and capable of being used in 18s mixing. The chief difficulty now experienced is, however, the organisation of proper marketing facilities for the produce and the ensuring of adequate premia for the quality of the growers of improved type to compensate them for the lower yields obtained. Every year enormous damage is done to cotton in several parts of India by the pink bollworm which is the worst pest of cotton in India. The United Provinces Entomological Scheme was started in 1923 with the object of determining the amount of damage done by the pink bollworm and of devising suitable control measures. The work of the first few years clearly demonstrated that the damage to the United Provinces cotton crop from this pest ranged from 25 to 75 per cent. and that the remedy for preventing the re-infection of the crop which generally arose from live larvae carried in double seeds consisted in heating the seed to about 60° C. which was sufficient to kill the larvae without affecting the viability of seed. For the eradication of the pest, therefore, it was found that all seed in any selected area should be heat-treated. In 1929-30 an area of 23,000 acres of cotton was thus controlled in the last cotton season in Atrauli tahsil of Aligarh district, and the general opinion on the crop was that it was the best produced within living memory. Next year an area of 27,000 acres was sown with treated seed and it is estimated that the growers obtained an average increased yield of 50 per cent. in addition to a much better price for their produce. A scheme to extend these operations to the whole of Aligarh district is now under consideration.

The Agricultural Department of the BARODA STATE continued its policy of distributing pure seed of 1027 A. L. F. in the Navsari district. In the Baroda district it was found necessary to organise the seed-supply of Broach 91 as, in spite of the advice of the Bombay Department of Agriculture, the growers and ginners preferred this type to Deshi. In the Mehsana district a year's trial has shown that 1027 A. L. F. thrives well under irrigation. In the Amreli district Banilla has been found more suitable than local Mathio.

On the Central Farm at Ujjain in the GWALIOR STATE, the varietal trials with cottons expected to compete with the local Malwi cotton and selection work to evolve a good strain of Malwi cotton as well as manurial tests were continued during the year under review.

The attempt to incorporate into general agricultural practice the experience gained on the Mahlaing Farm in BURMA is being intensified by the Cotton Improvement Scheme sanctioned by the Indian Central Cotton Committee. Selection work on Wagali, Wagyi and Cambodia cotton is in progress and plant-breeding work is also in progress.

In the MYSORE STATE much research work is in progress on the Hiriyr Farm, *viz.*, trials to find wilt-resisting types, hybridization and selection work on indigenous and exotic cottons, and the study of inheritance of certain characters.

In INDORE STATE the Rural Development distributed considerable quantities of seed of selected Malwi, Verum and N. R. cottons in the Malwa Plateau, in the low country and in the Nemad district, respectively.

In BIKANER a small scheme financed by the Indian Central Cotton Committee was commenced in December 1930 with the object of obtaining by selection and hybridization improved types of Indian and American cottons suitable for cultivation in the canal irrigated areas and capable of spinning at least 25s counts.

In BENGAL an attempt is being made on the Rangamati farm to select the best cotton from the local types.

Co-operative Cotton Sale Societies. In a previous paragraph reference has been made to the Cotton Finance and Marketing

Enquiries conducted by the Indian Central Cotton Committee and the recommendations made to the Local Governments concerned on the reports of these investigations. A common feature of these recommendations was that all the Governments, *viz.*, of Bombay, Madras, Central Provinces and the Punjab were requested to help the development of co-operative cotton sale societies to provide the growers with a better outlet for their produce. During the year under review, 25 cotton sale societies functioned in the Bombay Presidency and cotton worth over 45 lakhs of rupees was handled by them. Most of these societies now act as a medium for the extension of improved varieties of cotton introduced by the Department of Agriculture, and the formation of more societies is to be welcomed from this aspect alone. In the Madras Presidency, the Loan and Sale Societies handled cotton among other agricultural produce. The Government appointed an officer in the grade of a Deputy Director of Agriculture to work under the Registrar of Co-operative Societies to give the technical assistance required by cotton sale societies, for grading and keeping under control the production and redistribution of pure seed of good strains and for the cultivation of cotton. There are at present five societies in the Presidency dealing in cotton. Besides these, there are a number of registered and unregistered seed societies and unions who obtain seed of improved types of cotton from the Agricultural Department, grow and dispose of the produce under departmental control, the Department buying back the seed at a premium. In the Mysore State there is only one society at Maradihalli dealing in cotton. The cotton handled by this society was Selection 69. In the Baroda State 17 societies with a total membership of 1,036 worked during the last season, ginning and selling co-operatively about 1,713 *bhars* of seed cotton.

4. Sugarcane.

The area under sugarcane in the various provinces and Indian States was 2,568,000 acres in 1928-29, 2,513,000 acres in 1929-30 and 2,785,000 acres in 1930-31, a decrease of 3.2 per cent. and then an increase of 10 per cent. in consecutive pairs of years. The produc-

tion of raw sugar (*gur*) was estimated at approximately 2,704,000 tons in 1928-29, 2,752,000 tons in 1929-30 and 3,193,000 tons in 1930-31.

Twenty-nine factories making sugar direct from cane worked in India during the season 1930-31, as against twenty-seven in the previous season and twenty-four in the year before. Eleven of these are situated in Bihar and Orissa, thirteen in the United Provinces, two in Madras and one each in Bombay, the Punjab and Burma. Recently a new factory in the Punjab started working and plans are ready to start several others in the white sugar tract next year. The production of sugar direct from cane by factories in India totalled 68,040 tons in 1928-29, 89,768 tons in 1929-30 and 119,859 tons in 1930-31, thus showing an increase of 32 and 33·5 per cents. in successive seasons. The average percentage recovery of sugar from cane in India also shows an improvement, having risen from 8·59 in 1927-28 to 9·07 next year and to 9·09 in 1930-31. It is gratifying to note that the general efficiency of the factories making sugar direct from cane is steadily increasing. Out of the twenty-nine factories that worked in India during the season 1930-31, the percentage recovery of two factories is above 10, of twelve factories above 9, of eleven factories above 8 and of only four below 8.

There are at present thirty-three concerns in India equipped for refining *gur*, out of which nineteen factories also manufacture sugar direct from cane. Of the former only three refined *gur* during the year 1931 and of the latter seven worked during the year. Four were silent and returns from three have not been received. There were thus ten factories refining *gur* as against eleven during the year 1930 and fourteen in 1929. Of the ten factories that refined *gur* during the year 1931, six are situated in the United Provinces, three in Madras and one in the Punjab. The production of sugar from refining *gur* or raw sugar in India was 31,032 tons in 1928-29, 21,147 tons in 1929-30 and 31,786 tons in 1930-31, thus showing a decrease of 32 per cent. and an increase of 50 per cent. in successive years, though the production in 1930-31 was only 2·4 per cent. above that in 1928-29. Thus the total amount of refined sugar manufactured

in India was 99,082 tons in 1929, 110,915 tons in 1930 and 151,645 tons in 1931.

A table is given below showing the production of sugar direct from cane and from refining *gur* during the last twelve seasons and indicating the relative advance in the production of sugar from cane, the recent decline of the production of sugar from *gur* and the steady increase in the home production of sugar.

Production of Sugar.

Year	Direct from cane	Refined from <i>gur</i>	Total
	Tons	Tons	Tons
1919-20	23,081	44,453	67,534
1920-21	21,562	48,614	73,176
1921-22	26,929	47,835	74,764
1922-23	23,906	50,210	74,116
1923-24	38,340	56,455	94,801
1924-25	33,835	33,621	67,456
1925-26	53,033	38,440	91,473
1926-27	62,992	58,426	121,418
1927-28	67,739	52,001	119,740
1928-29	67,980	31,005	98,985
1929-30	80,675	21,128	110,803
1930-31	110,736	31,758	151,494

The imports of sugar into India amounted to 868,800 tons worth Rs. 15,85,63,427 in 1928-29, 939,584 tons worth Rs. 15,51,41,924 in 1929-30 and 901,278 tons worth Rs. 10,53,80,827 in 1930-31.

The world production of sugar in the year 1929-30 as given by Messrs. Willett and Gray amounted to 27,316,145 tons showing a decline in production of 245,955 tons as compared with the previous year. The slight decline in crop would have had a slightly hardening effect on the market but for the stock position on 1st April 1929 (6,895,000 metric tons raw value) which made the situation unsatisfactory. Prices of sugar during the year gradually declined and

the Indian markets were also affected and declined on account of large imports of foreign sugar, specially of beet sugar, which increased from 8,000 tons in 1928-29 to 131,000 tons in 1929-30. Again in 1930-31 the world production of sugar amounted to 28,751,837 tons showing an increase of 1,441,257 tons over the previous year. Prices of sugar in Indian markets continued to decline. The price of Java sugar in Indian markets gradually declined in consequence of Java's lowering her prices frequently owing to difficulty in the marketing of her crop of 1930. On the 14th April 1930, the price of Java sugar in Calcutta was Rs. 9-4-3 per maund and the price declined to Rs. 8-1-6 on the 25th November 1930. The market improved from 1st week of January 1931, in anticipation of an increase of import duty on 1st March 1931. The price rose to Rs. 8-15-3 per maund on 31st March 1931. Though the import duty was increased by Rs. 1-4 on 1st March 1931, the market could not rise proportionately on account of heavy accumulation of stocks in private godowns.

The IMPERIAL SUGARCANE BREEDING STATION at COIMBATORE continued the breeding of improved canes and further progress was made both in breeding technique and in studies of the germination of sugarcane pollen, the period of stigmatic receptivity and controlling the times of flowering of the parents. The wild *Saccharum* received some attention with the object of including useful types as parents. An advance of great interest made during the period was the intergeneric hybridization of sugarcane and sorghum. These hybrids that flowered during the season were studied with regard to their inflorescence characteristics, and additional evidence about the genuineness of these hybrids was obtained from the following peculiarities in certain of the hybrids--sorghum-shaped inflorescence, the awned fourth glume and the greenish white stigmas. The hybrids exhibited quite a large number of abnormalities. The Co. numbers of the sorghum hybrids that have been distributed to the various provincial stations for trial are Co. 351 to 357, and under Coimbatore conditions these hybrids ripened in about six months and fair quality *gur* or jaggery was obtained from laboratory samples of the juice. It can now be claimed that these hybrids are likely

to yield short duration canes. The bulk crossing for the breeding of medium or thin type of canes consisted of Co. 213 \times Co. 244. This cross was effected as it had yielded canes of considerable promise in North India. Another combination that has yielded promising types is Co. 281 \times Co. 290, and the utility of Co. 214 as a parent for introducing early maturity and good sucrose content has again been proved. The frost was rather severe during the 1930-31 season, and certain of the Coimbatore seedlings stood it better than most indigenous kinds in the Punjab. Some of the Coimbatore productions are said to have shown comparative resistance to *Pyrilla* which was very severe in parts of the Punjab and the United Provinces, indicating the possibility of breeding in future canes resistant to this pest. The spread of Coimbatore canes in cultivation in North India has been one of the factors responsible for the increased efficiency of the Indian factories.

From funds sanctioned by the Imperial Council of Agricultural Research a small sugarcane sub-station was started at Karnal, and seeds obtained from crossed and selfed flowers at Coimbatore were successfully germinated at Karnal. These seeds were preserved in an atmosphere of carbonic acid gas before despatching to Karnal. In connection with an investigation at the Sugarcane Research Station at Shahjahanpur, a batch of 5,000 seedlings of Co. 213 \times Co. 244 was despatched to Shahjahanpur after having been pricked into pans and specially treated to stand the journey. The breeding of thick canes, which started much later than that of medium and thin canes, had reached a stage at which eight selected seedling canes were distributed to nine experimental stations. The numbers of these seedling canes are Co. 358 to Co. 365. Four were despatched to four stations in Northern India for trial as chewing canes. In connection with breeding of thick canes, rather extensive cytological observations were in progress on duplication of the generative nuclei, the development of the embryo and the number of chromosomes in certain varieties. Sugarcane pollen was stored alive for seven days in a pulverulent condition by keeping it over calcium chloride and a temperature ranging from 8°C. to 13°C. This pollen when cultured artificially gave 12 per cent. germination. The

duration of stigma receptivity in certain of the thick cane varieties was found to range from 8 to 11 days.

PUSA. Since Co. 205 had been discarded by the sugar factories, it became a matter of urgent importance to replace this cane. During both seasons the higher sucrose content of Co. 285 (15 per cent. in November against 12.66 per cent. in Co. 205) combined with high tonnage, drought-resisting capacity, rapid growing quality, and other desirable agricultural habits confirmed its superiority over Co. 205. If it turns out well in the large-scale mill trial next season, this variety will be recommended for planting in those parts of the white sugar tract for which it is suitable. Co. 295 and three new canes of this class Co. 317, Co. 318 and Co. 319 were obtained from Coimbatore to test against Co. 285. Co. 299 and Co. 281 gave better results in comparison with Co. 214 which is the standard early cane. Co. 281 is steadily improving and shows signs of becoming acclimatized to conditions in North Bihar. Co. 300, 301, 302, 303, 304, 312, 313, 316 and 331 as well as B. S. 3 and B. S. 11 all show promise. Tonnage experiments designed to compare the yields of Co. 210 and Co. 213 indicated a 15 per cent. increase of Co. 210 over Co. 213, when grown on lighter land. These two varieties of economic value are grown extensively all over North Bihar as well as other provinces. When grown under their most suitable conditions they hold their own anywhere—yet they have their limitations. For example Co. 213 needs considerably greater rainfall and strong soil, while Co. 210 appears distinctly superior on lighter soils. The time has now arrived to separate these canes and grow each under its optimum soil conditions.

In the manurial experiments with sulphate of ammonia and nitrate of soda, the average yields of Co. 210 was 518 and 447 maunds respectively, and of Co. 213, 441 and 399 maunds respectively. Sulphate of ammonia applied at two maunds per acre as a top dressing, in two doses in the middle of January and middle of July, in addition to standard manuring, gave the best results.

To estimate the cost of production on the farm, sugarcane was grown on three different blocks during the year 1930-31 and cost of all operations was carefully recorded. At the New Area the average

cost per acre for growing sugarcane on a block of 28 acres was Rs. 116. This includes Rs. 65 per acre spent on manures. The average yield per acre was 409 maunds and the cost per maund was annas 4·53. In Bhograsan field (ten acres) variety tests, the cost of cultivation amounted to Rs. 98 per acre with an average yield of 445 maunds per acre and the cost per maund was annas 3·52. Twenty acres were planted under Co. 205 in Brickfield II low land as a non-experiment general field crop grown without manure. Whole canes were planted in furrows opened by means of three-row ridger. The average cost per acre was Rs. 49 while the yield amounted to 378·5 maunds. Cost per maund was annas 2·27. A method of safeguarding the seed-supply of early ripening canes was successfully worked out by wrapping them with cane trash.

Rogueing on the farm at Pusa for five years has reduced mosaic disease on all varieties except Co. 205 to eleven clumps in 40 acres of cane but on Co. 205 the disease has been only partially reduced. Fortunately Co. 205 is now a discarded cane. In the test for the natural spread of mosaic, where a row of 50 yards long of each of 25 varieties is alternated with a row of mosaic-infected cane, the old canes were ratooned but no new cases of mosaic disease appeared in any of the test rows. The mosaic disease lowered the weight of stripped cane by 4·6 per cent. in Co. 213 and 8·6 per cent. in Co. 205 and reduced the quality of the juice slightly.

The UNITED PROVINCES contain the largest acreage of cane in India, the area being 1,357,000 acres in 1928-29, 1,362,000 acres in 1929-30 and 1,488,000 acres in 1930-31. The area under improved cane has increased very considerably. The total area under improved cane in the United Provinces was 281,000 acres in 1928-29, 515,000 acres in 1929-30 and 678,000 acres in 1930-31, so that now 48 per cent. of the area is under improved cane. This extension is probably the greatest single achievement of the Agriculture Department during the last few years and shows the eagerness with which cultivators take up a new idea after they are satisfied that it is to their advantage. Another potent factor has also operated to this end. The prices of all the agricultural produce fell considerably but the price paid by the sugar mills for the cane remained un-

changed. Under the present conditions this is the only crop to which the ryot can turn as a revenue crop, and its cost of production can be considerably reduced owing to oil-cake for manuring being available at cheap rates. The present price of oil-cake is Rs. 1-8 per maund in the market as against Rs. 4 paid last year. Co. 213 is said to have deteriorated in the province, but there are ample quantities of other excellent varieties of disease-free canes to take the place of this variety. In 1929-30 the average produce of Co. 213 sugarcane in 10 plots treated with green manuring with *sanai* was about 910 mds. of sugarcane per acre, while the average outturn per acre of the same variety without green manuring was 660 mds. Another variety Co. 243 gave 854 mds. per acre with green manuring and 575 mds. without. The cost of sowing and turning *sanai* per acre is about Rs. 12-5, while the extra yield obtained was about Rs. 94 in the case of Co. 213 and Rs. 104 in the case of Co. 243. There is thus a handsome profit. Green manuring not only benefits the sugarcane crop to which it has been applied, but it leaves a reserve of plant food in the soil which can be utilized by succeeding crops.

BIHAR AND ORISSA. Co. 210, Co. 213 and Co. 214 continued to be most profitable varieties in North Bihar where cane is grown without irrigation, and these varieties are rapidly ousting Hemja and Bhurli. An early application of phosphates at Sepaya in North Bihar not only increased the outturn but also raised the richness of the juice considerably while the late application decreased both the outturn as well as richness of the juice. Nitrogenous application did not make any difference, whether the heaviest dose was applied early at the time of planting or in the rains at the time of earthing up. In South Bihar Co. 213 has spread rapidly in the canal area of Shahabad and in the cane tracts of Gaya and Patna. Co. 205 has proved itself very hardy under adverse conditions, water-logging and flooding, but as it contains much fibre it is a difficult cane to mill, so white sugar factories have in many cases discarded it. The work at Pusa already outlined has, however, showed that Co. 285 can with great advantage take its place and has indicated promising other alternatives. At Sabour experimental

work was carried out on the production of *gur* from palmyra palm juice. The object of this work was to extend the sugarcane *gur* making season. The cane *gur* making is finished by April and at that time there is a plentiful supply of juice in palm. Excellent samples of *gur* were obtained and it is proposed to manufacture white sugar on a small scale next season. The Imperial Council of Agricultural Research has sanctioned a grant of Rs. 1,60,000 spread over five years for sugarcane research. It has also sanctioned a grant of Rs. 8,000 for the design of a satisfactory small power cane-crushing mill the need for which was keenly felt in the province.

PUNJAB. The use of improved canes in the Punjab is now rapidly increasing. The estimated area under Coimbatore canes in 1929-30 was 80,000 acres and in 1930-31 104,400 acres which represents 24.5 per cent. of the total area under sugarcane. Owing to scarcity of good seed at sowing time due to frost, the ratooning of the crop was resorted to in many cases and has given very good results. In order to popularise the cultivation of improved sugarcane varieties, Government sanctioned during the year the free transport of Coimbatore sugarcane sets on a small scale to new growers. The comparative values of the various varieties of cane studied show that in general the Coimbatore varieties are better in every respect than the indigenous, though of the latter Saretha is holding its own in the Southern Punjab. In the Central districts the local cane Katha has yielded on the average about half the tonnage of the Co. varieties. Of the latter Co. 285 is the heaviest yielder, though Co. 281 has the highest sucrose content. In the sub-montane tracts of Gurdaspur and Sialkot, Kahu has yielded the highest tonnage amongst local varieties. Co. 285 had done well everywhere, though Co. 270 and Co. 290 have beaten it in sucrose content and the former also in tonnage. The effect of potassium nitrate, superphosphate, ammonium sulphate and ammonium phosphate was studied on Co. 223 grown at Gurdaspur Agricultural Station. It has been noticed that the weight and the period of maturity of sugarcane were affected by the use of the fertilizers, while the sugar-content changed slightly; that sugarcane manured with potassium nitrate matured early and was least

affected by frost while the application of ammonium sulphate and ammonium phosphate delayed the ripening; and that potassium nitrate and ammonium sulphate have been found to be comparatively more economical than the other two fertilizers. The effect of flowering of sugarcane which is a rare phenomenon in the Punjab was studied on Co. 285. It was observed that the weight of a cane in flower was actually more than that of a flower-less cane without any difference in the amount or quality of juice. The results of the experiments conducted in studying the various methods of preparing *gur* confirm previous experience that brisk boiling is superior to slow boiling and that inversion of sugar depends more upon the PH value of the juice and the time during which boiling is continued than on the temperature. Further work has been done on the clarification of cane juice and the preparation of *gur*, using different clarifiers and different temperatures. From the results got it appears that the phosphatic contents of the juice exercise a considerable effect on clarification, juices low in phosphates clarifying better by the addition of phosphoric acid. The economics of the methods employed have not yet been worked out; therefore the final results have not been published. Investigation on the loss of tonnage in sugarcane affected by mosaic disease was undertaken. The results obtained at Lyallpur seem to show that a definite loss in tonnage results from mosaic infection. On an average the healthy crop appeared to yield 21 per cent. cane, 17 per cent. juice and 21 per cent. *gur*, more than the mosaic-affected crop. The experiment, however, is not conclusive and is being repeated. Owing to the heavy frost in the previous year, cane sets were scarce all over the Province, and therefore ratooning was resorted to on a more than usual scale. This perhaps has something to do with the general prevalence of *Pyrilla* in the year. Experiments to determine the effect of a severe attack of *Pyrilla* on the yield of sugarcane showed that both quality and quantity were definitely affected and ripening was delayed. The study of the relative extent of damage done by sugarcane borer on different varieties of sugarcane was continued and one highly susceptible variety showed damage as high as 90 per cent. In the vicinity

of Gurdaspur sugarcane fields were attacked to the extent of 25 to 30 per cent. By way of control the removal of the damaged central shoot and treatment of the cavity thus created, with petrol spirit or derrisol, resulted in a mortality to the pest varying from 30 to 90 per cent.

MADRAS. Work on this crop is mainly confined to the research stations at Anakapalle, Samalkot and Palur. The chief items under investigation were varieties, manures and methods of manuring, methods of cultivation and rotation. With regard to varietal experiments, an attempt is being made to replace J. 247 at Samalkot; and P. O. J. 2878, the wonder cane of Java, is showing promise. The yields at the station this year are better than the average due, it is believed, to the introduction of a longer rotation and growing the crop on new land free from water-logging. At Palur varietal tests are being continued in garden and wet lands and J. 247 still seems to lead having yielded 946 maunds cane per acre, followed by P. O. J. 2714 giving 887 maunds. The manurial work is mainly directed towards discovering what effect the partial or total substitution of ammonium sulphate for oil-cake has on the crop, and so far it would appear that at all three stations a partial substitution can be made with advantage. From an irrigation experiment conclusions arrived at are that planting early in February is not an advantage and that Co. 213 can be grown with the normal rainfall supplemented by only 4 acre-inches of irrigation at the time of planting. It is found that this variety is more drought-resistant than J. 247.

The rotation experiment on sugarcane at Palur has been continued for 8 years. The yields of cane of the four, three and two-year rotations were 33.74, 29.28 and 24.32 tons per acre, respectively. The outturn of sugarcane in each rotation showed a net profit of Rs. 359, Rs. 280 and Rs. 258, respectively, for all the eight years. The net profits of the several rotations taking all the crops together are, respectively, Rs. 81, 51 and 49. These results show that a wide rotation of sugarcane seems favourable.

BENGAL. Co. 213 has struck the imagination of the cultivator and is spreading rapidly in the districts. Before its advent the

old Tanna, formerly recommended by the department, was grown throughout the province but now Co. 213 is rapidly replacing it in most places. About 10 lakhs of cuttings of Co. 213 were supplied by the departmental farms in each of the two years but a much larger exchange has also taken place between cultivators themselves. Results of recent cutting-out experiments indicate that as a result of the spread of departmental cane, the average yield of *gur* has risen substantially. The next stage is to introduce power-crushing and improved boiling apparatus so as to reduce the cost of production. The Agricultural Engineer has already produced hopeful results in this direction with the help of a grant from the Imperial Council of Agricultural Research. Some new canes show promise, notably P. O. J. 2725, P. O. J. 2714, Co. 245, Co. 270 and Co. 313. As has already been demonstrated at Pusa, October planting appears to have had considerable success in the Brahmaputra and Ganges silt areas but in the red soil the result is still doubtful. The Imperial Council of Agricultural Research has granted funds for the establishment of a small cane seedling testing station at Dacca. This station is one of a chain of similar stations in Northern India and valuable results are expected from a comparison of the behaviour of different canes at the respective stations.

ASSAM. Work at Jorhat consisted mainly of the acclimatization of varieties of cane and of cultural and manurial experiments. The following varieties so far have proved most suitable:— P. O. J. 2714, Co. 213 and several others show promise.

BURMA. Gillman and Striped Mauritius have established themselves as the best of the earlier introduced varieties. The Java cane P. O. J. 2878, a new introduction, shows vigorous growth and is a good ratoon cane. It has met with much favour among the cane-growers in the Pyinmana neighbourhood. The superiority of this cane over the local cane may be realized from the fact that the experiments at Pyinmana have proved that it yielded 5.19 tons of sugar per acre against 3.19 of the local variety. The introduction and testing of varieties are being continued. In addition seedling canes are being raised for testing. The effect of fertilizers on the growth of the cane crop is being studied. The

results show a substantial response to the application of nitrogenous fertilizers, the yield per plot of cane having increased with each increase of fertilizer up to a limit. The addition of phosphate to a nitrogenous fertilizer did not give any further increase in the output of cane. An examination of the local pit method of planting and the cheaper method of laying the sets in a furrow shows that there is a marked increase in the output of cane in favour of the pit method. The increased output from this method more than compensates for the economy in the cost of cultivation of the furrow method. Much work is in progress regarding manurial experiments but the results are not yet ready for analysis.

BOMBAY. Much work has been done in Manjri with regard to the testing of varieties but it is difficult to beat the local Pundia. The four thick varieties, *viz.*, Striped Mauritius, Manjav, J. 247 and Red-sport, were the favourites of the ordinary Malbari cane-growers and have now largely replaced Malbari. Of the thin canes Co. 210 and Co. 213 are preferred where there is scarcity of water or where the water is brackish. As a result of the visible effect on the crop by the use of sulphate of ammonia as top-dressing on Amalsad farm, it is largely used in the adjoining tract and in course of time will become the general practice with cane-growers there. Manurial experiments at Kunta farm confirm the conclusion that sulphate of ammonia is not very effective in acidic soils and requires a combination of phosphoric acid. A comprehensive sugarcane research scheme is to be launched in the near future and the site for the research station will be near Lonad on the Nira Right Bank Canal. This is a big scheme having for its main objective the production of cane at a much lower price than has hitherto been prevailing. It is hoped to achieve this goal by producing a more thrifty cane than the existing Pundia which will require less manure and which will occupy the land for a shorter period of time than Pundia.

CENTRAL PROVINCES. The area under this crop shows no sign of extending. Work on cane is at present almost entirely restricted to one or other of the numerous types which have been raised at Coimbatore and subsequently tested out and proved on the

various experimental and demonstration farms of the province, in respect of their yield, quality of *gur* and resistance to disease. They are steadily replacing local canes. The particular Coimbatore cane in popular demand varies slightly from district to district. The Mycologist has had this crop under special observance in respect to the damage done by Agya (*Striga*) and its control. It was found that the application of a 3 per cent. solution of copper sulphate destroyed *Striga* which is parasitic on the roots without damaging the sugarcane. Mosaic disease has apparently but little effect in these provinces.

NORTH-WEST FRONTIER PROVINCE. Many varieties have been tested at the Tarnab Agricultural Station. Otaheite or the Peshawar Pounda is the best cane on rich and abundantly irrigated land, while Assam Red is considered most suitable where the water-supply is limited and the land not so fertile. Co. 213 is rapidly displacing other thin canes in Hazara and Bannu where, due to milder climatic conditions, ratooning is possible. At Peshawar cane does not ripen well and the cultivator is much behind in the methods of producing sugarcane and manufacture of *gur*. The yield this year ranged from 60·76 maunds to as low as 30·38 maunds per acre. At the Haripur Agricultural Station, Co. 213 has been successful for the last five years and it is hoped that very soon it may become a leading variety. The advantages of the Sultan three-roller mill were demonstrated at Haripur and the cultivators acknowledged it to be better than the two-roller machine. In the Peshawar district the three-roller mill has already displaced the less efficient two-roller one, while at Bannu the two-roller mill is still commonly employed to crush the thin cane which alone is grown there.

5. Jute.

The total area under jute in the three provinces of Bengal, Bihar and Assam during 1929-30 was 3,415,000 acres, a rise of 8 per cent. over the previous year. Towards the end of the year the trade depression began to affect the jute market and there was

a considerable fall in prices. Cultivators had fair warning, but in spite of this the area sown in 1930 rose just over three per cent. to 3,531,000 acres. The area grown in Bengal was 88 per cent., in Bihar 7 per cent. and in Assam 5 per cent. The outturn of jute for 1929 was 10 million bales of 400 lbs. which was just a little less than the previous year's crop; and in 1930-31 it was 11.2 million bales. During the first year under review, the season was favourable except in eastern Mymensingh and Tipperah where crop was damaged by floods which did such serious damage in Assam that the crop there was reduced by 35 per cent. Jute is the only crop which the average Bengal cultivator can sell to obtain money for rent, clothes, bullocks and other necessities of life. He spends little in cash in producing the crop. Rent he must pay and he may have to buy seed but he only employs outside labour in years of exceptional prices. It is only when the price of paddy exceeds that of jute that the cultivator can expect to obtain a greater gross return from paddy as an alternative crop. He thus maintains his acreage under jute even when faced with declining prices.

Seed of departmental races D. 154 and Chinsurah Green continued to be sold through the Government Selling Agent, Narayanganj. The Agent disposed of 320,000 lbs. of seed for 1929 sowing. It is estimated that about 9 million acres were sown with departmental races of jute, and as D. 154 gives an average increased yield of 240 lbs. per acre and C. G. 400 lbs. per acre over local races, the increased return to cultivator amounted to over two crores of rupees. The increasing area under Government seed led certain members of the jute trade to attribute the poor quality of the jute coming forward to the use of Government seed, and this question was discussed with the trade in Calcutta. Since 1923 experiments have been conducted in collaboration with the trade to compare the quality of the Government races D. 154 and R. 85 with local races, and a race called Fanduk was selected by the trade as being of the finest quality. These experiments were conducted on Government farms and at the agencies of baling firms throughout the jute-growing tracts in East and North Bengal. The fibre was submitted to assessors selected by the trade both in Calcutta and

Dundee. Over a period of five years the points were distributed in Calcutta as follows :---

D. 154 (Government seed)	R. 85 (Government seed)	Fanduk	Local
74	82	74	49

and the average yields per acre were :—

D. 154	R. 85	Fanduk	Local
1,489 lbs.	1,403 lbs.	1,208 lbs.	1,198 lbs.

It is thus obvious that Government seed is not a factor affecting the deterioration in quality. That deterioration has taken place cannot be denied but it is due to several causes. Improved machinery in the mills enables the consumers to manufacture fibre which, owing to its inferior quality, would not have found a market in the past. With the demand exceeding the supply, any quality is accepted by the mills but when heavy supplies are forthcoming the mills pick and choose and complaints are common. The remedy lies with the trade. If the cultivator obtains sufficient premium, he will devote time and care to producing clean quality fibre. At present he gets paid for stick, bark and root as fibre. With clean fibre he loses the weight and does not get an equivalent enhanced price for his pains. The Agricultural Department has impressed upon cultivators the advisability of clean and careful retting, but this advice will not be readily accepted if the cultivator receives no appreciable premium for clean fibre.

Jute manufacturers in India in 1929-30 embarked on a policy of expansion of production by working 60 hours a week instead of 54 hours in the mills, though at this time there was less movement of trade commodities throughout the world and consequently less demand for gunny bags and hessian. This arrangement resulted in the accumulation of heavy stocks that could not be sold at even much reduced prices. In 1930 the weather conditions were favourable all over the jute area and the result was a bumper crop which really aggravated the depression in the trade which was already serious during the previous year. In April 1929, the

quotation for "Firsts" in Calcutta was Rs. 66 per bale of 400 lbs., but it fell to Rs. 44-8 by March 1930 and to Rs. 28-4 by March 1931. These prices in Calcutta were low indeed but it must be remembered that the growers got much less and at times they could with difficulty dispose of their fibre at Rs. 2 to Rs. 2-8 per maund. It will thus be seen that the course of raw jute prices throughout the period under review was disastrous to all concerned. Fortunately a bumper crop of rice was obtained and as a result of vigorous Government propaganda and financial assistance in the shape of agricultural loans, the area under *rabi* crops was extended and foodstuffs were plentiful and cheap. Government and landlords had to postpone collection of rents, and Government officers were engaged in intensive propaganda advocating the restriction of sowings and the substitution of other crops such as sugarcane for jute. Cultivators, as a rule, are reluctant to reduce sowings in case neighbours do not and score if prices rise. In spite of this, sowings in 1931 were reduced to an estimated area of 1,858,100 acres, 53 per cent. of the area sown in the previous year. Through the Government Selling Agent, 220,000 lbs. of departmental jute seed were sold to cultivators, sufficient to sow 25,000 acres. Natural extension of the area under the improved varieties continued, and it is now difficult, particularly with *Obitorius*, to obtain seed of local races for testing purposes. Cultivators are beginning to appreciate the fact that departmental seed is more remunerative than local seed even in lean years, for they can obtain the same quantity of fibre from a reduced area and keep land for food crops. A cultivator growing $\frac{4}{5}$ ths of an acre of local jute receives the same quantity of fibre as a neighbour growing $\frac{3}{5}$ ths of an acre of departmental jute, and the latter has an additional $\frac{1}{5}$ th acre to put down to paddy.

6. Other fibres.

Hemp. At Pusa eight old types of *Hibiscus cannabinus* and 4 old types of *Hibiscus sabdariffa* were maintained. Several crosses were made and their progeny studied. The new type of the latter, mentioned in the previous Review, thrived well and was

immune to the sclerotial disease which attacked *Cannabinus* types rather severely. Some seed of *Hibiscus sabdariffa* var. *Altissima* a type commonly grown in the Philippines, was received from the Director of Agriculture, Philippines, and produced plants that looked the same as the "new type" isolated at Pusa. Some fibre of this "new type" sent to the Imperial Institute, London, was rather favourably reported on. The fibre was harsher and coarser than jute and of a strength slightly superior to that of Bimlipatam jute. Grown at Dacca and other places in Western Bengal, it seemed to do well and it is intended to give it a thorough trial next season when the quality of the fibre will also be tested.

Sann-Hemp (*Crotalaria juncea*). Owing to competition with better quality hemp obtainable from other countries, the trade in Indian hemp has been declining considerably. The decline has been due in a large measure to the increased use of hard fibres for the manufacture of twine and cords in preference to Indian hemp. As a general rule, Indian hemp was preferred only when its price was relatively lower than that of other fibres. Despite the favourable crop and lower prices in India in 1929-30, the exports of hemp declined by 22 per cent. both in quantity and value, from 561,000 cwts. valued at Rs. 87.5 lakhs in 1928-29 to 435,000 cwts. valued at Rs. 68.3 lakhs. Again, next year, they fell by 33 per cent. in quantity and 42 per cent. in value, to 293,000 cwts. worth Rs. 39.5 lakhs. With the exception of 1921-22 these were the lowest recorded since the beginning of the century.

As mentioned in the last Review, the Imperial Council of Agricultural Research appointed an officer for seven months to enquire into and report on the condition of the sann-hemp trade, and he visited the most important hemp-growing tracts in India including the United Provinces, Central Provinces, Bihar & Orissa, Bengal and the Bombay and Madras Presidencies. Among the objects of study were the suitability of the various tracts for the production of hemp, the methods of cultivation, retting processes, modes of extraction, preparation of the fibre, baling operations and the existing systems of marketing in up-country production centres. Results of experiments which had been carried out in the various

parts of India were examined and the subject-matter of the enquiry was discussed with all persons and bodies concerned with the growing and handling of the fibre. His report does not claim to be an exhaustive treatise on the subject, but it is hoped that the tentative findings and proposals embodied in it will be helpful in evolving constructive schemes. It will be considered by the Imperial Council of Agricultural Research some time next year.

At the instance of the Advisory Committee on Vegetable Fibres, Imperial Institute, London, experiments on retting to determine the critical period for plants to remain immersed in the retting process were undertaken in Daeca and samples of fibre sent to London for valuation, where they elicited the opinion that $3\frac{3}{4}$ - $4\frac{1}{2}$ days' retting at $75-79^{\circ}$ F. is the optimum.

In the United Provinces an investigation was made into the possibility of improving sann-hemp by chemical treatment, either by adding small quantities chiefly of ammonium salts or bleaching agents like sulphites, or by chemical treatment of the retted fibre with a view to improve the tensile strength. Some treated and untreated bales were sent to London for report. The selection of sann-hemp made in 1926, known as Cawnpore 12, grows taller than the local varieties and yields more fibre of better quality as regards length, colour and texture. Its seed has been supplied to many centres in India and favourable reports have been received.

In the Central Provinces extensive experiments relating to the effects on the fibre of varying conditions of sowing and retting were conducted on the College Farm, Nagpur, and at Adhartal and Chindwara Farms. Three factors were kept in view: conditions of growth, length of the retting period, and temperature of retting. Three-hundred samples were sent to the Indian Trade Commissioner for valuation and from the reports so far received, it appears that a seed-rate of 60-90 lbs. per acre yields a satisfactory fibre and that the retting period will have to be lengthened during the cold months.

Flax. In BENGAL two exotic races of flax ('Riga' from seed supplied by a firm and pedigree J. W. S. the seed of which was supplied by the Linen Industry Research Association, Lamberg)

were grown at Dacca, Dinajpur, Berhampur, Malda and Rangpur and the straw was sent to the Lamberg Research Association for extraction and valuation. It is reported that the Bengal samples were priced higher than the best Irish marks. The one-year-acclimatized seed was again sown and samples have been sent to Lamberg: the report is awaited. Flax appears to have great possibilities in North Bengal. The difficulty is in the extraction; the technical processes of retting and skutching will have to be undertaken by capitalist or co-operative agencies.

7. Tobacco.

The total area under tobacco was 1,308,000 acres in 1928-29, 1,317,000 acres in 1929-30 and 1,257,000 acres in 1930-31. The total yield of dried leaf was 599,000 tons in 1928-29, 629,000 tons in 1929-30 and 572,000 tons in 1930-31. The bulk of the tobacco grown is consumed in the country but there is a small though valuable export trade, chiefly of unmanufactured leaf, much of which goes to Great Britain because of the custom's rebate of about 2 shillings per pound given to Empire-grown tobacco. In 1928-29, 14,700 tons were exported valued at Rs. 123 lakhs but in the next year there was a marked fall to 11,600 tons valued at Rs. 99 lakhs, the decrease being most noticeable in shipments from Bombay. In 1930-31 the amount went up to 12,900 tons but the value was only Rs. 96 lakhs on account of the fall in price. The establishment of cigar factories in Great Britain, Africa, Australia and New Zealand in order to secure the advantage of the tariff protection, has diverted a large share of the demand for Indian cigars to the home-made articles. Brands of mild quality to compete with the imported Dutch and Manilla cigars have shown an improved demand. There is an import of unmanufactured tobacco chiefly from America for making higher class cigarettes and for cigar wrappers and pipe tobacco. In 1928-29 the quantity was 5,350 tons valued at Rs. 274 lakhs. Next year there was a fall of 15 per cent. in quantity to 4,520 tons valued at Rs. 270 lakhs. There is little doubt that the high duties imposed in March 1927 served as a handicap to the continued expansion of this trade. Again in

1930-31 imports fell by 51 per cent. to 2,200 tons valued at Rs. 151 lakhs. This unprecedented fall was chiefly in the import of unmanufactured tobacco due to the boycott of cigarettes all over India, though the economic depression had also something to do with it.

At Pusa, during the period under review, further experiments in flue-curing were carried out. The new hybrid No. 177 maintained its quality and yields of about 1,000 lb. dry cured leaf per acre were obtained with this type. With the object of improving the quality of an indigenous tobacco to suit cigarette manufacture, a local Type 28 was crossed with an American Adcock in the year 1924. This has resulted in evolving ten hybrids which have now become fixed in their characters and are breeding pure within narrow limits like the original parents. Several other crosses are at various stages of examination. Attempts have been made to grow tobacco in Bihar in the rains, sowing and transplanting being done about three months earlier than normal. While the scale on which this has been tried is so far limited, the experience gained indicates that the incidence of leaf-spot and leaf-curl diseases are likely to prove the limiting factors for the cultivation of tobacco in the rains in Bihar. Hybrids 142, 164 and one of the indigenous types (Type 49) were grown and flue-cured. Hybrid 142 yellowed very quickly in the barn and also gave a percentage of yellow leaves which was much higher than in the case of other hybrids hitherto tried. Hybrid 164 also cured fairly well but it was lower in quality and yield to hybrid 142. Type 49 could not be cured to a bright yellow colour, and this further confirms that none of the indigenous types are much good for flue-curing. A sample of flue-cured leaf of Type 177 was tested by the Indian Leaf Tobacco Development Co. and reported as equal to leaf valued at As. 8 per lb. Besides hybrid 177, other hybrids tried were 192 and 196. Both these are heavy yielders but they are late and all their leaves do not ripen uniformly and quickly, hence they have not proved superior to hybrid 177.

On a commercial scale there has been a great increase in flue curing in India and this method has now almost entirely supplan-

ted the old rack-curing method in the production of cigarette tobacco. With the establishment of flue-curing on a large commercial scale we may consider that a definite stage has been reached in the tobacco researches commenced at Pusa in 1924.

In the MADRAS PRESIDENCY tobacco is grown in two tracts—one in Guntur and the other in Trichinopoly. In the former tract several exotic varieties introduced for cigarette-making by tobacco firms were extensively grown and flue-curing was taken up on a large scale but, in the latter year under review, the firms had to close their branches with disastrous results to the growers, as the flue-cured leaf was not suitable for local consumption and unsaleable. Work on the local varieties is required at the Research Station, Guntur, but no systematic work with regard to selecting varieties, methods of cultivation and curing has yet been started. In the Trichinopoly tract two promising varieties, Pusa 28 and Havenna were found to be superior to the local tobacco and have sold at a substantial premium.

At the Tobacco Station at Nadiad in BOMBAY two strains No. 6 and No. 28 proved definitely superior in three years trials and seed is being distributed. A large number of selections made from the local crops and several crosses are being studied for their economic characters. To test the general belief that the smoking character of tobacco bears some relation to the number of leaves left on the stem at the time of nipping, an experiment has been carried out for four years leaving from 10 to 20 leaves, but the results from year to year are not uniform.

In BENGAL, though heavy rain delayed transplanting and hail did some damage, the seasons were favourable and the crops good. Still the experience of both seasons indicated that seedlings should be transplanted as early as possible, as a difference of a fortnight at this time made a great difference in growth and yield. Though the main work on tobacco was done in the Government Tobacco Farm, Rangpur, yet several other farms were also engaged in it chiefly in producing seed and seedlings for distribution to surrounding growers. Over 5 lakhs of seedlings were distributed each year and about 1,730 tolas of seed. So great has been the demand that

arrangements have been made on selected farms to grow seed and seedlings under departmental supervision. Several exotic varieties were grown and great care was taken to instruct and help cultivators with the crop. The main varieties were Motihari, Bhengi, Pennsylvania, Sumatra, Manilla II, Vuelta, several American varieties like Ohio, Orinoco Yellow Prior, Hickory Prior. White Burley and Warne were under trial as well as two Turkish varieties Aysolouk and Cavalla. In several districts these exotic tobaccos have been grown by the cultivators and the results showed that the production of high-grade cigar tobaccos in Bengal is more than a possibility and that with reasonable care the province can produce cigar-leaf capable of taking its place in the world's market.

Most of the tobacco of BURMA is grown on land annually enriched by deposits of silt from the flood waters of the big rivers. Thus it requires no manuring, yet the average yield is from 800 to 1,000 lbs. of dry leaf per acre. Experiments at the Sa-aing Farm, which comprises $10\frac{1}{2}$ acres worked as an annexe of the Allanmyo farm, were continued. Eight varieties of tobacco were under trial and the curing of these was carried out in ventilation-controlled barns of the Bengal type. All the tobaccos cured are of fairly good colour but the prominent veining of the leaves of Burmese Havana, Sumatra and Pusa 28 is against their popularity. Cheroot-rolling was continued as in previous years, using only the tobacco which has matured for two seasons. Cheroots made with Manilla tobacco for filler and Pennsylvania for wrapper are best liked. A slight alteration in the design of the curing barns has been made; the Bengal type, found to be costly, was lowered by one tier. The Deputy Director is doubtful if these or any other type of curing barns are satisfactory. For experimental work in tobacco-curing what is required is a barn for flue-curing but this will have to await the provision of the necessary finances. In the meantime work will continue mainly with a view to the production of a superior type of cheroot.

Tobacco is an important crop in NORTH BIHAR and its cultivation is very carefully done by a special class. Pusa 28, a selection from a North Bihar tobacco, is a heavy yielder and much sought

after by the *mahajans*. At Sabour, comparative yield-trials in, 1930-31 showed that the selection Pusa 28 gave a better yield under irrigation than the hybrid Pusa 117 but work will be continued as the latter has the asset of being a good chewing tobacco, so that when the cigarette manufacturers do not purchase it, there is still a local market.

8. Oil-seeds.

The estimated area and yield of the principal oil-seeds in 1929-30 and 1930-31 as compared with 1928-29 are shown in the following table :—

	1928-29		1929-30		1930-31	
	Area in thousands of acres	Yield in thousands of tons	Area in thousands of acres	Yield in thousands of tons	Area in thousands of acres	Yield in thousands of tons
Rape and Mustard .	7,038	910	5,907	1,095	6,586	991
Linseed . . .	3,109	322	2,802	380	3,020	378
Sesamum . . .	5,513	495	5,316	455	5,501	526
Groundnuts . . .	6,357	3,211	6,748	2,668	6,366	3,108
Castor . . .	1,410	113	1,285	116	1,452	118
Cotton-seed . . .	..	2,100	..	1,018	..	1,777
TOTAL .	23,451	7,151	21,088	6,632	22,988	6,808

In 1929 the production of cotton was 5,285,641 bales and the output of cotton-seed calculated at .36 of a ton per bale may be estimated at 1,910,000 tons. Similarly, in the succeeding year 4,912,000 bales would correspond to 1,777,000 tons of cotton-seed. A considerable change has occurred during and since the war in India's export trade in oil-seeds. Local consumption, which is steadily on the increase, has been able to outbid a weak foreign demand. Only with regard to linseed is the export demand trying to overtake the previous level. In copra, for instance, India's exports averaged 31,000 tons annually in the pre-war period but in 1926-27 they dwindled to 2,000 tons and now have practically disappeared. In linseed, cotton-seed, rapeseed and sesamum there has also been a substantial reduction in India's exportable surplus compared with the pre-war figures. But in the case of

groundnuts internal consumption has not yet overtaken the increased production resulting from extended cultivation, with the result that much larger quantities are available for export. The table below shows the quantities of the principal kinds of seeds exported during the last three years and in the pre-war quinquennium :—

	Thousands of tons			
	Pre-war average	1928-29	1929-30	1930-31
Linseed	379	157	248	257
Rapeseed	273	77	44	33
Groundnuts	212	788	714	601
Castor	114	121	106	91
Cotton	240	131	58	41
Sesamum	119	30	11	1
Copra	31	..	..	..
Others	85	24	14	13
TOTAL	1,453	1,328	1,195	1,037

The exports of vegetable oils and oil-cakes have also been declining as will be seen in the following table :—

	1928-29	1929-30	1930-31
Vegetable oil in gallons	1,586,000	1,348,000	1,140,000
Oil-cake in tons	328,000	273,000	254,000

Rape and Mustard. The United Provinces has half the acreage of these crops in India, the other important provinces being the Punjab (1,000,000 acres), Bengal (750,000 acres), Bihar and Orissa (700,000 acres) and Assam (350,000 acres). Only a small quantity of these crops was exported.

At PUSA, a number of samples were collected from all over India in 1929-30 for investigation and isolation of types. The information regarding the scientific and vernacular names of these species in the Indian works on Botany is very confusing. The best available record is found in Prain's valuable article, "Mustards cultivated in Bengal," published in the Agricultural Ledger No. 1 of 1898, which of course deals with only one province. A tenta-

tive classification of the species and sub-species has been made. All the samples have been grouped into nine species, out of which only three are self-fertile. The work of isolation of types has been taken up in these species and will be completed soon. The remaining six species, which are self-sterile, form a good material for investigation of the sterility problem, and various experiments in this direction have been undertaken. In the PUNJAB, BIHAR and ORISSA and ASSAM the isolation of pure lines was also in progress and breeding work was attempted. In the meantime mass-selection and drill-sowing have been found to increase yields.

Linseed. The area under linseed is about 3 million acres, chiefly in the United Provinces (955,000 acres), Central Provinces and Berar (806,000 acres) and Bihar and Orissa (806,000 acres), the acreages being given for 1930-31. The linseed crop of 1929-30 was 18 per cent. better than in the preceding year, being estimated at 380,000 tons. Next year it was 378,000 tons. At Pusa the various pure types were maintained and 32 types of linseed and flax were received from New South Wales for comparison. The genetic results of the crosses made between Types 12 and 121, the two best small-seeded types of Northern India, and several of the bold-seeded types of peninsular India were published in 1931. The most promising types among the hybrids have been tested for yield and oil-content. The study of the inheritance of characters has thrown light on some very important points.

In the UNITED PROVINCES, tests have shown that certain cross-bred strains are better and more disease-resistant than the best local selections.

In the CENTRAL PROVINCES, the selection known as E. B. 3 is the best for Berar and the Nagpur and Chhattisgarh divisions, but the Pusa varieties so far tested have proved to be unsuitable for the conditions obtaining in these provinces. Hybridization between a local type and Irish flax which is very rust-resistant has given promising results.

Cultivation of linseed is tending to increase in Orissa. Of the three types, Pusa 12, 121 and Sabour 6 under trial, those from Pusa were found to be better yielders but the Sabour type, on

account of its wilt-resistance, excelled the Pusa types in years when wilt was severe. Hybridization with a view to unite those characters is in progress.

In BENGAL, a survey of the local types has been completed. Some local selections have been found to be superior to the Pusa types because the latter are not early-maturing enough to suit conditions in Bengal.

Sesamum. Sesamum is largely used for local consumption for edible purposes, etc., and its export has declined to insignificance. At PUSA an account of the unit species and a study of the growth of sesamum in different soil conditions with special reference to root development was published, while a study is now being made of the inheritance of characters. Sesamum is an important crop in the dry zone of UPPER BURMA but is liable to be destroyed by excessive drought or excessive rainfall. Work with early and late strains was continued by the Economic Botanist at Mandalay. Some gave promising results and six were multiplied for distribution. One of them that showed marked immunity to green flower and wilt has become very popular and the department is, on account of this success, succeeding better with its demonstration of line-sowing.

Groundnut. The four chief areas in which this crop is grown are Madras with 3.5 million acres, Bombay with 1.5 million acres, Burma and Hyderabad State each with half a million acres. The production of groundnuts in 1929-30 was estimated at 2,668,000 tons or 17 per cent. less than the previous season's record figure, while the crop of 1930-31 was 3,108,000 tons. Exports consisting largely of decorticated nuts constituted a record at 788,000 tons in 1928-29 but declined to 714,000 tons in 1929-30 and further to 601,000 tons in 1930-31.

In MADRAS, an Oil-seeds Specialist was appointed and he has been busily engaged in organising the various investigations and in growing and studying different varieties of this crop. In BOMBAY, the strain No. 5 of Spanish Peanut continued to find favour and 29,000 lbs. of seed were distributed in 1929-30 and 38,000 lbs. in

1930-31. Experiments showed that a groundnut-jowar rotation gave better results than tobacco-jowar or cotton-jowar, and that groundnut and jowar in alternate rows gave better results than either in blocks with jowar in the rotation and the intention is to follow up this line of work. An agricultural survey of this crop in BURMA was completed and published. Groundnut is grown chiefly in the dry tracts mainly in rotation with sesamum, the yield of which is materially increased thereby, but in the riverine tracts a short-season erect type of Spanish groundnut was reported to be extending rapidly. For a number of years trials have been going on at various centres with a view to single out varieties with high outturn and maximum oil-content and to decide the best spacing. Four spreading and two erect types have been chosen as good performers. In HYDERABAD, Kanki 17, a variety from Bihar, gave good promise and was multiplied at almost all the farms for distribution to cultivators. Groundnut cultivation is extending rapidly in BERAR as a rotation crop with cotton and plays an important part in the agricultural economy of these tracts. The two varieties which are in commonest demand are Small Japan and Spanish Peanut. The latter is a high yielder, with a better percentage of oil, but on account of being prone to easy germination in the field, is suitable only for areas where later rains are not common. A new variety known as Akola 10 has passed the experimental stage and has been found to be a better yielder than the Small Japan and Spanish Peanut. This variety is being widely distributed for further trials. Two factors are retarding the spread of groundnut, the cost of lifting and scarcity of labour during harvesting. A special form of plough, used at the Akola farm, ploughs the soil and simultaneously brings the crop to the surface, and this effects a saving of Rs. 5 per acre. Regular markets have been established in Berar for the disposal of this crop, where nearly 100,372 acres are under groundnut cultivation and number of oil-mills have also sprung up. The department maintained 1,814 and 2,099 private seed-farms for this crop during 1929-30 and 1930-31, the total amount of seed distributed being 57,653 and 59,636 maunds in the respective years.

The Chota Nagpur and Orissa Feudatory States in BIHAR AND ORISSA offer a suitable field for the cultivation of this crop, the two obstacles in the way of its spread being the cost of harvesting and damage done by jackals. Both these difficulties could be met by having an early harvest, and the problem is being investigated at the Kanke farm from three points of view : the use of phosphatic manures to induce early ripening, substituting an early-maturing variety and early pre-monsoon sowing.

In MYSORE, a number of varieties from all parts of the world were under trial. Hybridization work has progressed and the hybrids are being tried in the districts. A recent importation, Valencia, appeared very promising. It has been found that liming and manuring increase the yield to a marked extent and there is a better development of the shell also.

Castor. Rather more than half the area under castor is in HYDERABAD STATE and about 20 per cent. in Madras. In that State individual plant selections have been made which are superior both in yield and in oil-content. A comprehensive scheme for plant-breeding of castor was submitted to the Imperial Council of Agricultural Research.

In BOMBAY, the commercial varieties were classified botanically and selections made from pure lines, nine of which were tested at Poona and Nadiad. Work along this line is to be continued at Prantij in the heart of the castor-growing tract. Similar work was done in the UNITED PROVINCES.

Coconut. In Madras work was continued on manurial, varietal, distance and depth-of-planting trials at Pilicode ; on the effect of cattle manures, fish guano and ashes in different quantities at Nileshwar ; on the study of the characters of units from different coconut-growing centres of the world and crossing and selfing at Nileshwar ; and on manurial requirements and cultural problems at Kasargod. On account of the efforts of the department, large areas of dry land have been brought under coconut cultivation, and there is a keen demand for seednuts and seedlings. In addition to the nurseries maintained by the department, there were 16 private nurseries under the guidance of demonstrators. 34,539

seedlings and 890 seednuts in 1929-30 and 20,905 seedlings and 3,735 seednuts in 1930-31 were distributed to the ryots. Plots where proper planting, manuring and methods of inter-cultivation were demonstrated numbered 688 in 1930-31. *Nephantis serinopa* is a serious pest in the West Coast but the control measures of cutting and burning infested leaves and liberating parasites have had considerable effect in reducing its ravages both in Madras and in Travancore.

Through the efforts of the Department of Agriculture in TRAVANCORE STATE the area under coconuts is gradually extending. Economic work was carried on at four stations. Varietal, cultural, spacing and manurial experiments were carried out with a view to getting the most suitable data for the various types of soil. At the Akyab Agricultural Station in BURMA, in the manurial and cultural schemes laid down 4 years ago, 45 per cent. of the trees began to bear in the treated blocks against 10 per cent. in the untreated blocks.

Tung Oil. The tung oil trees *Aleurites fordii* and *A. montana* are quick-growing, medium-sized trees, the fruit of which produces china wood oil that, on account of its rapid drying property, is valuable in the manufacture of paints and varnishes, particularly motor-car varnishes. They were introduced into BURMA in 1929 from seed obtained from Hankow in China. Planted in small areas at Maymyo, Mandalay and Hinawbi the seeds germinated well and so far the plants have grown well. Cultivation on a larger scale on about 720 acres was undertaken by private enterprise in the Northern Shan States and the trees have come on so well that extension of the area to double that acreage is contemplated. The Agricultural Chemist, Burma, examined a number of soils on which it was proposed to grow tung and, as at the present time the only definite information regarding soils on which tung grows is to the effect that it prefers an acid soil, the investigation was limited to this point. In the result it would appear that many soils in the Shan States are suitable.

The services of the Royal Botanic Gardens at Kew have been given to securing its wider distribution in the Empire and through

the Royal Botanic Gardens, Calcutta, a good many estates in India especially in the tea-growing districts have undertaken to experiment with it on various soils and at different elevations. Besides these, trial plots have been laid down near Ranchi in Bihar and Orissa and at three elevations on the southern slopes of the Nilgiris. The growing of tung in India is yet in the experimental stage and, though it holds out distinct promise, it has still to be established that planting on a commercial scale will be remunerative.

African oil palm. At the Mudon Agricultural Station, BURMA, the African oil palm showed vigorous growth and flowered in the fourth year. The plant for the extraction of palm oil arrived but had not been worked before the end of the period under review.

9. Tea.

Tea is grown in three main areas in the Brahmaputra and Surma valleys of Assam, in the Darjeeling and Jalpaiguri districts of Bengal and in South India, chiefly in the Mysore and Travancore States and the Nilgiris, Wyanad and Coimbatore districts of Madras Presidency.

The total area under tea in India was 756,000 acres in 1927, 775,900 acres in 1928, 788,000 acres in 1929 and 805,800 acres in 1930, showing a small but steady increase from year to year, and of this area approximately 90 per cent. was plucked. The total production of tea was 391 million lbs. in 1927, 404 million lbs. in 1928, 433 million lbs. in 1929 and 391 million lbs. in 1930. The production for 1929 was a record figure.

The year 1929 was exceptionally favourable to the production of tea. The favourable climatic conditions prevailing throughout the year supplemented by an absence of blight led to record crops. The continued policy of manuring helped by a better supply of labour tended also in the same direction. The general standard of quality in 1929 was not altogether good but could be described as useful. As usual Assam contributed the largest share, *viz.*, 259 million lbs. or 60 per cent. of the total output while Northern India, excluding Assam, contributed 116 million lbs. or 27 per cent.,

and Southern India 58 million lbs. or 13 per cent. The production in Assam increased by 13 million lbs. whereas that in the rest of Northern India increased by 15 million lbs. and in Southern India by half a million lbs. The outstanding feature of the tea trade this year was a serious drop in prices, which at certain stages of the season were definitely below the cost of production. The average price per pound for the season in the tea auctions in Calcutta was 9 as. 4 ps. as compared with 11 as. 4 ps. in 1928-29 and 14 as. 10 ps. in 1927-28. This remarkable fall in prices was not, however, justified by the quality of the season's crop, for the general standard was not very much below average. The chief explanation lies in the over-production of tea in all the tea-producing countries of the world.

The year 1930 was not so favourable for the production of tea as the previous year. Drought and hail-storms in the early part of the year, unusually heavy rain in June and again in August and cool wet weather in autumn caused a great decline in output. In spite of the unfavourable weather conditions, the general standard of quality may be described as good average. Assam contributed 233 million lbs. or 60 per cent., the rest of Northern India 102 million or 26 per cent. and South India 56 million or 14 per cent. Production in Assam decreased by 26 million lbs., in the rest of Northern India by 13 million lbs. and in South India by 3 million lbs. This great decrease was due partly to the unfavourable weather during the season and partly to the operations of the agreement to restrict the output of tea in the chief tea-producing countries, India, Ceylon, Java and Sumatra. The average price of tea per pound realised at the Calcutta auction sales during the season was 9 as. 4 ps., being 7 ps. lower than the average for the previous year. On the whole, however, the tea industry was not depressed to the same extent as most other industries, the chief cause for which was the healthier outlook created by the restriction agreement reached about the middle of April, 1930.

At Tocklai the Scientific Department of the Indian Tea Association continued the investigation of tea problems both from the agricultural and manufacturing points of view. The work on the

chemistry of the tea-leaf was concerned mainly with the extraction, preparation and estimation of tannin in the tea-leaf, with the effect of manuring on the tannin-content, with the oxidation and condensation products of tea-tannin and with the changes in tea-tannin observed to take place during the manufacture of tea. A preliminary investigation on the pharmacology of tea was undertaken. In the first year of the experiment manuring with nitrogen, potash and phosphate, alone or in combination, has no significant effect on the tannin-content of the leaf, and no significant change in potash or phosphoric acid content of the leaf that is used for tea making. These results do not support the theory that manuring has any great effect on quality. The work on manures will be discussed further in Chapter III.

The observations made in 1930-31 on the starch reserves on plucked bushes confirmed those made in previous years, *i.e.*, that a period of rapid growth is usually accompanied by a fall in starch reserves while a period of slow growth is usually associated with an accumulation of starch. On unplucked bushes the same observations were made but, in addition, there was some indication that a temporary fall in starch occurred during the filling of the seeds. The removal of mature leaves of bushes from the beginning of July to the end of the season caused a drop in the reserve starch content, and this fact makes it easier to understand why black rot and other diseases which reduce the area of mature leaves on a bush may cause serious loss in crop. The results of plucking individual bushes of both dark and light-leaved types clearly showed that the highest yielding bushes were producing at least 70 per cent. more crop than the average of the bushes concerned. This increase appeared to be due to the greater number of shoots plucked and not to the increase in size of the individual shoots.

It has been established that tea can be propagated by green shoot cuttings and further progress was made with this work during the year, but it is too early to draw any particular attention to this as it will be first necessary to grow the bushes to maturity. It is of interest to note that Russian scientists have repeated the experiment with successful results. They claim to have obtained

73 per cent. of successes. The investigation on the flowering and fruiting of bushes was continued.

The influence of bacterial control in relation to tea manufacture was established during the period under review and some of the effects of bacteria determined. It was shown that bacterial infection can take place at any stage of manufacture, the result depending on the species of organisms concerned, the intensity of the infection and probably the temperature of the factory. Evidence also pointed to the fact that the virulence of any particular species may vary according to its condition of growth. With this knowledge it has been found possible to account for various defects in tea manufacture and to devise measures for their elimination.

On the agricultural side, work was done on trials of different varieties of tea, pruning, skiffing, plucking, cultivation and manuring. It has been suggested in some quarters, that labour and other difficulties might be minimised by inducing the tea bush to flush during the cold weather when bushes under normal treatment are dormant. The two factors which might prove effective in producing cold weather crop are manuring and pruning. Previous trials have proved the inefficacy of late manuring. Whenever the manure be applied, bushes close up at the same time. Heavy manuring does lengthen the season at both ends a little but the crop in the cold weather months is still inconsiderable. In some years a fair December crop can be taken, though generally the delay in pruning necessary to take it would lead to losses of greater amount in the following season. There is no hope of obtaining crop in paying quantity during January and February in the climate of Assam. Districts of North-East India which remain warmer and have a longer period of daylight would make a little more tea in the cold weather, but hardly in quantities likely to pay for plucking and manufacture. As against annually pruned tea which yields very little in March, April and May, unpruned tea will yield quite well in these months. The use of some unpruned tea to yield in March, April and May is the only practicable method of lengthening the plucking season in North-East India, and this

practice is attended by the disadvantage that having to cut two years' old wood entailed by the use of unpruned tea causes larger and less easily healed wounds which tend to deterioration of the frames of the bushes.

All results were in accord with the natural assumption that crop depends directly on the food-supply to the bush. Manuring experiments showed that crop-increase is proportional to the quantity of nitrogen supplied, up to a very high limit, and that in comparison with nitrogen other food substances make extraordinarily little difference. Even in a rich soil the nitrogen naturally present is insoluble in water and therefore unavailable. It is rendered available by conversion to ammonia and nitrates by soil bacteria. It has been shown that plant roots excrete substances toxic to nitrifying bacteria. The presence of weeds therefore hinders the supply of available nitrogen. Among heavy thatch grass, for example, nitrates can hardly be detected at all, while at the same time nitrates may be in quite high concentration in similar soil when clean. Tea among jungle is therefore starved. The nitrogen rendered available by cultivation is produced at the expense of the soil's reserve of insoluble nitrogen (old plant residues), and cultivation by producing a good supply of soluble food must cause an increased rate of deterioration of the soil. Good cultivation alone, therefore, cannot maintain good crops of tea over long periods. Hence in experiments it was observed that the more poorly cultivated plots were increasing in yield relatively to the better cultivated.

For example :—

Yields in maunds tea per acre.

—	1926	1927	1928	1929	1930	1931
11 light hoeings .	11.70	11.76	12.30	14.94	14.00	15.59
6 " " .	10.17	11.78	12.21	15.00	14.60	15.82
4 " " .	6.36	8.42	8.63	11.17	10.78	13.69
Sickling only .	3.67	5.27	4.83	5.46	6.04	7.72

In 1926, eleven light hoeings were still yielding more than six light hoeings but thereafter yields have been about equal. Since the tea began to give good cover, 6 light hoeings have kept the land as clean as have eleven light hoeings, so that if suppression of jungle were the main object of cultivation, this result would be expected. Four light hoeings, however, given as they are at 60 days' interval, still allowed very considerable jungle growth, so that it was more surprising to find this plot giving 54 per cent. of the crop from eleven light hoeings in 1926, and 87 per cent. in 1931. Similarly, the crop from sickling only rises from 31 per cent. to 50 per cent. in 1931. In this last case the bushes were still too small to provide much cover, except in patches where a few good bushes growing together have kept down jungle. Presumably the more poorly cultivated plots have maintained the better soil.

Taking all the results on the various blocks in the station together, it appeared to be quite clear that suppression of weeds is the chief function of cultivation; that any system of cultivation which fails to achieve this object is inefficient; and that (at least in comparison with jungle suppression) soil stirring is of little importance. Similarly it has been shown that the effects of cultivation can be secured without actual work with hoes, by supplying the necessary soluble nitrogen as manure in place of rendering available through cultivation the soil's reserve of nitrogen.

At DEVARSHOLA in the Wynaad, the Scientific department of the United Planters' Association of Southern India investigated similar problems applicable to the southern area, *e.g.*, pruning, skiffing, manuring, application of sulphur to increase the acidity on soils where this is necessary to get a better growth of the bushes. Much time was devoted to the chemical investigation of tannin in tea-leaf and in made tea. Further samples of the theo-tannin have been prepared; the analyses of these samples have indicated the necessity for modifying previous conceptions of theo-tannin. Various derivatives, bearing in mind the technological perspective, have been prepared and investigated. Temporary concepts of the constitution of theo-tannin have had to be modified. Work done on made tea has not led to such conclusive results as is the

case with green leaf investigations, but even so the results obtained are enlightening, although no complete explanation of them is at present possible. This work has shown that the oxidation theories of the fermentation of tea are somewhat exaggerated representations of the true facts. The amount of oxidation taking place during this process is, indeed, very small and cannot explain the production of the colour of fermented leaf and tea infusions. A limited amount of oxidation takes place, but the major cause of the obvious changes during manufacture will more probably be found to be a result of hydrolysis. It also appears that pectins are far more important in their bearing on the characteristics of tea infusions than has been suspected in the past. It has been established that, within limits, the proportion of oxidisable true non-tannins in green leaf is approximately constant and there is strong evidence that by using the iodimetric method a single estimation of the total oxidisable value can be utilized to give a close approximation to the true tannin value without performing the precipitation of tannin, which is not only tedious but a mine of possible inaccuracies dependent on small variation in technique. It has been found convenient to study the seasonal variation of the tannin-content of green leaf at the same time. Comparative analyses by the iodimetric and formalin methods were carried out on a large number of 'made teas'. Bulk samples and grades from a number of estates were investigated. Teas from individual estates showed marked similarities between themselves, but significant differences were found between the South Indian teas at present investigated and Ceylon teas similarly analysed. The investigation is being continued as rapidly as possible and, when the analyses have been completed, definite explanatory hypotheses can be adduced.

10. Coffee.

The cultivation of coffee is mainly confined to Southern India in the hilly tracts of the Madras Presidency, Coorg and the States of Mysore, Travancore and Cochin. The total area under coffee remained fairly constant, being 160,667 acres in 1928-29, 163,516

acres in 1929-30 and 160,852 acres in 1930-31. The figures are, however, not strictly accurate in that estates or holdings of less than ten acres do not furnish returns and accordingly are not taken into account in compiling the statistics. In the last year under review, Mysore had 51 per cent. of the total area, Madras 24 per cent., Coorg 23 per cent. and Cochin and Travancore together 2 per cent. The total production of cured coffee amounted to 247,938 cwts. in 1928-29 or 3,500 cwts. below that of the previous year, 352,000 cwts. in 1929-30 and 294,437 cwts. in 1930-31.

The exports during 1929-30 declined by 7 per cent. in quantity from 198,000 cwts. to 184,000 cwts.; and by 14 per cent. in value from Rs. 169 lakhs to Rs. 145 lakhs. The demand for Indian coffee in the markets abroad during 1930-31 was very satisfactory and exports increased to 293,000 cwts. valued at Rs. 192 lakhs, representing an increase of 59 per cent. in quantity and 32 per cent. in value.

At the Coffee Experimental Station at Balehonnur in MYSORE STATE, an effort was made to get growing in the State all the commercially important species and varieties of coffee which might be of any use in breeding work. Selections were made and a considerable amount of hybridizing was done. The first definite cross between *C. arabica* and *C. robusta* produced in India has been planted out. The main object of this work is to produce a variety with the quality for which Mysore coffee is famous and resistance against leaf-disease and 'die-back'. In addition, work is being energetically carried on with the hope of immediate benefit on manuring, on the investigation of fungus diseases and insect pests and trials of fungicides and insecticides, and on grafting of scions from selected bushes on to disease-resistant root-stocks. The first two items of work have already begun to yield results of great practical value and as regards the last item distinct progress has been made.

11. Rubber.

Hevea brasiliensis, the rubber tree, is grown in the hinterland along the Malabar Coast of South India and in Southern Burma.

The total area under rubber was 167,000 acres in 1928, 170,900 acres in 1929 and 172,000 acres in 1930. In the last year the relative acreage in the two rubber-growing areas was 55 and 45 per cent., respectively. The area tapped was 112,177 in 1929 and 104,283 in 1930. The decline in yield was due to the intentional reduction of the area tapped. During the period under review, the rubber trade was passing through one of the worst slumps it ever experienced. Over-production for some years past in almost all producing countries of the world contributed materially to bring about this situation, and large exports from the East, in consequence of the release of many tons of rubber after the period of restriction, had the effect of increasing stocks and bringing down prices. The export of raw rubber from India in 1928-29 was 11,527 tons; next year it was almost the same at 11,506 tons, while in 1930-31 it fell to 10,414 tons. In May 1929 the price of ribbed smoked sheet in London was 11½d. per lb. but it fell to 7½d. in March 1930. Next year it fell almost continuously to 3½d. in March 1931. Thus the value of the exports from India has fallen tremendously from Rs. 200 lakhs in 1928-29 to Rs. 179 lakhs and then to Rs. 130 lakhs in the two years under review.

At the Rubber Research Station at Ancikulam in TRAVANCORE, a block of 87 acres has been sprayed annually for the last five seasons with Bordeaux mixture to prevent the damage done by *Phytophthora medii*. It is claimed that the experiment has been successful both from the healthy appearance of the trees—the block appearing as a green island in the country-side during the period of second leaf-fall—and from the increased yields. Spraying was fairly extensive throughout the rubber-growing area, especially on nurseries and young plantations. The application of a disinfectant mixture has effectively controlled bark-rot. Much attention has been paid to experiments on budding from high-yielding trees and to the possibility of discovering at the nursery stage which are the plants that will give a high yield at a later stage of growth. Recently an examination of rainfall and crop distribution has been made and the data collected suggest that a study of cultural operations suited to the irregular distribution

of South Indian rainfall may yield useful results at no very distant date. This, while probably never assuming quite the same importance as the raising of higher-yielding strains of trees, may go far to reduce the average cost of cultivation.

12. Fruit.

This crop, from the economic aspect far less important than the food and money crops of India, has for this reason received less attention and less financial aid in the research connected with its problems than has been its due. Now, however, the necessity for fresh fruit in human diet having been established and more widely recognised, new interest has been awakened in the potentialities of the fruit gardens and orchards of the country, the immediate result of which has been the appointment of fruit experts in various agricultural departments in the provinces. Their activities, if encouraged, should in the near future lead to useful improvement in the supply of good quality fruit not only for use in the home market but for increasing profitable export abroad.

The climatic conditions of the NORTH-WEST FRONTIER PROVINCE are pre-eminently favourable for fruit-growing. In the lower valleys the peach, plum, apricot, pear, grape, pomegranate and quince flourish and in some places the orange and lemon do well. In the markets of Northern India the demand is good and the railway is encouraging the trade. After twenty years of experiment the orchard practice at Tarnab is said now to be practically that which is customarily carried out in the progressive commercial orchards of the world and the aim of the department has been to establish fruit-growing in orchards on a commercial scale where the trees can be properly cared for and effectively protected against diseases and insect pests. The leading varieties are those which are grown in the great orchards of California, South Africa and Australia and the practice in planting, intercultivation, manuring, irrigating, spraying, pruning, picking and so forth is similar to that carried out in the countries mentioned. The yield per acre and the quality of the fruit are not inferior. This year 200 lbs. of peaches per tree were picked. Only the Japan-hybrid or Burbank varieties of

plum bear freely at Peshawar. The European plum does not bear fruit. On the other hand, the Japan-hybrid usually has more fruit than the unsupported branches can safely carry. In the Peshawar valley some trees bear as much as 500 lbs. of good fruit. Although the price per maund of plums is always less than for peaches, the crop is heavier, the trees do not need spraying, pruning is less expensive, the packing charges are light. On the whole plums are fully as profitable as peaches. The earliest variety of value ripens about the middle of May, the latest towards the end of August. The demand markedly declines when the best peaches come in early in July. All the world over, the apricot is notoriously inconstant in bearing fruit. On the average the crop is good at Tarnab only in alternate years. Being cheaply grown and much appreciated in the markets, a fair profit per acre per annum is gained. Thus far one variety only yields satisfactorily, but further trials of several promising kinds are being made. The apricot kernel grub (*Eurytomid Sp.*) which has practically destroyed the once valuable Hazara trade in this fruit has not yet reached Peshawar. Parts of the Kohat district, the Kurram and other elevated valleys are suitable for this fruit. During the recent visitation locusts appeared to like the apricot far more than any other fruit. The Peshawar "Batang" pear has long been appreciated in India's markets, and large quantities are exported in September, October and November. Although the orchards have considerably extended in the past few years, the demand still is good. A new pear named Le Conte, a hybrid between the Batang and the most popular of all market varieties, the Bartlett, which was freely distributed after due trial about ten years ago, is now bearing well in many orchards. Soon it will be as popular as the Batang and it certainly is not less profitable. The Keiffer is another late keeping hybrid that will be valuable when the growers are willing to store the fruit until it is ripe enough for marketing. Because the grapevine is afflicted by the leaf hopper (*Jassid Sp.*) grapes cannot be grown in the Peshawar Khalsa, excepting on fairly high trellis or over a tree. In an experimental vineyard at Tarnab some years ago, it was decided that as the hopper could not economically

be controlled, the production of grapes might be left to the cultivators of that tract which extends from Bad-ber to Bara Fort. There on the rich, deep alluvium, irrigated by the silt-charged, fertilizing red Bara water, grapes are grown to some perfection, and the leaf-hopper gives no trouble. In June and July when showers might injure the ripening branches, rain seldom falls. On this tract irrigation is almost too uncertain for the production of field crops, yet is sufficient for grapes. Here there is scope for establishing modern vineyards capable of supplying every market in India with grapes of first class quality. The cultivation of the pomegranate and quince is so simple that the Department has given less attention to them. Beyond finding in a trial that the most appreciated foreign quince varieties do not bear well or ripen perfectly at Tarnab, nothing to improve the production of this fruit has been undertaken. In the hot Peshawar Khalsa, under Kabul river irrigation, on efficiently-drained, fertile land, the orange is not thrifty and fruitful for more than ten or twelve years. On the other hand, in certain parts of Mardan and Charsadda which are irrigated by the Swat canals, the orange may have a long prolific life. For the Malta or Washington Navel the rough-lemon (*Citrus limonum* Osbeck) is the best stock: the Sangtara is most vigorous on the *mitha* (*C. limonum* var. *mitha*). Unlike the orange the lemon grows and bears extraordinarily well almost everywhere in the Peshawar district. In tests during the last five years, the lemon stored in earthenware vessels has kept well up to five months. From the Tarnab nurseries 20,000 budded peach, plum, apricot and pear trees were distributed in each of the two seasons under review.

In BOMBAY, the Horticultural Section has rendered useful service in assisting the public to establish fruit orchards. Thus, over 3,000 *bor* trees were budded in different districts, notably in Satara and Kolaba. In Khandesh one owner has as many as 800 improved *bor* trees as the result of the assistance of the horticultural staff. In Khandesh, 400 Dholka pomegranate plants were supplied to agriculturists in Nashirabad village of Jalgaon taluka. The Taluka Association, Satara, distributed 10,000 Basrai plantain

suckers with the aid of the Department. In North Gujarat, 2,122 grafts were supplied, while in Broach district the number of fruit-stock distributed was 557, with limes predominating. There is a keen demand for advice on horticultural matters in the canal zone of the Deccan, and useful assistance has been rendered in teaching the people how to prune grape vines correctly. The area under fruit trees is increasing in this tract, and here every effort should be made to foster the fruit industry. Further research has been carried out on the problems connected with the preparation of fruit juices from such fruits as lime and *jambul*, the latter of which is believed to have highly anti-diabetic properties. Work on the production of other fruit products including the candying of the *bor* fruit and the preparation of syrups has been in progress. The total quantity of fresh fruit and vegetables imported into Bombay by land and sea and the system of marketing and transport facilities available have been thoroughly studied and recommendations have been made to organise and improve the situation. In this province, as in the rest of India, the mango stands high in the list of popular and important fruits and continuous attention is now being given to the problems connected with it. Fruit is marketed by the growers and up-country dealers in a primitive manner, though in the Crawford market in Bombay grading of a high quality is the practice.

The Department has been demonstrating methods of grading and packing at Ratnagiri. Experiments in the latter have proved the superiority of wooden cases over bamboo baskets both as regards cost and the condition of fruit on arrival at the market. As regards grading, in 1931 about 2,000 baskets were graded by merchants with the aid of two departmental officers and in the early part of the season (*i.e.*, the latter part of April) there was an additional profit of Rs. 5-12-0 per hundred on graded over ungraded mangoes. With a view to the exploration and acquisition of new markets, trial consignments of Alphonso mangoes were sent in 1930 to Aden, Cairo, Marseilles and London and arrived in fairly good condition. Again in 1931 with the co-operation of the Empire Marketing Board and with the help of a small grant given by the

Imperial Council of Agricultural Research, small consignments of the best Bombay varieties of mangoes were despatched to London by the Government Horticulturist, Poona, by P. and O. Mail Steamers and kept during transit in the purser's cool room where the temperature ranged from 40° to 50°F. The fruit arrived in a fairly satisfactory condition and found a ready market. On the other hand, a large consignment was rather precipitately exported to London by a merchant without adequate arrangements for its transit or disposal, and the result has emphasised the need for an investigation into the problem of cold storage. It is hoped that, when a scheme now under consideration for the study of this problem fructifies, the subject will receive the intensive investigation it deserves.

Under the aegis of the Empire Marketing Board in a preliminary experiment at the Lister Institute, three varieties of mangoes were tested for the presence of vitamins with the result that the pulp of the Alphonso variety was found to be one of the most potent sources of vitamin C (anti-scorbutic), the Cowasji Patel variety was slightly less active but was as potent as the previously best known natural anti-scorbutic source, while the Shendrya variety contained in comparison little vitamin C. The pulp of all the three kinds contained vitamin A (anti-infective) in quantities similar to that possessed by butter but no very significant amount of vitamin D (anti-rachitic) was found in the pulp of any of them. As is mentioned in the report,* it would be unwise at the present stage to dogmatise too much from these results because the investigation is still in the preliminary stage but, in view of the importance of the mango, these experiments on fresh fruit might with advantage be repeated and further experiments made on preserved and canned fruit to ascertain the changes brought about in the vitamin-content by the treatment to which the fruit is submitted.

Work on horticulture in BURMA was confined mainly to the stations of Hmawbi, Mudon and Myaungmya. The Hmawbi

* Preliminary Report on the vitamin content of the mango. By Perry, E. O. V. & Zilva, S. S. Published by the Empire Marketing Board. (London: H. M. Stationery Office, March 1932.)

garden, 30 acres in extent, is by far the most important and has now reached the stage when the distribution of seedlings and grafts has become possible. During 1930-31, 952 plants of mango, plantain, lichi, citrus and guava were distributed. The Agricultural Assistant in charge of this Station conducted a survey of the fruit and vegetable supply of the Rangoon market. Some of the mango varieties flowered too late to suit Lower Burma conditions and are probably better suited to Upper Burma where they will be tried. The sapota continued to grow vigorously and most of the trees fruited. This fruit, which is not available in the bazars of Burma, is one of the species suitable for general introduction, especially as it comes into season in the hot weather when other fruits are scarce. The area under Kew pineapple is being gradually extended.

At Mudon the mangosteen, which is here in its native habitat, received much attention. Experiments have been made in shipping mangosteens to England in collaboration with the Empire Marketing Board and in bottling the fruit for use in the country or for export. Bottling experiments have only been commenced in 1931 and no results are as yet to hand. In connection with the experimental consignments of mangosteens to Europe, it is clear that the fruits must be shipped in cold storage as those shipped in ordinary storage arrived in very poor condition. Wastage was mainly due to rotting by *Diplodia*, a fungus which does not develop appreciably at temperatures below 50°F. All the fruits shipped in cold storage arrived in good condition and remained sound for some days after arrival. What is required to be done is to conduct experiments to find out the proper temperature at which this fruit should be shipped. The report of the Empire Marketing Board stated that "Samples of the mangosteens were shown to members of the trade who were distinctly interested and asked to be kept informed of the progress of the experiment. Numerous enquiries were also received from members of the public as a result of press paragraphs and of the mention of the consignment in the broadcast news bulletin. In view of the interest aroused, it seems possible that there are good prospects of a limited market for mangosteens if they can be shipped in consistently good condition".

The appointment of a Fruit Expert in the PUNJAB has awakened interest in the starting of commercial orchards and in the supply of plants from controlled nurseries at Lyallpur and the other Government farms of Gurgaon, Gujranwala, Sargodha and Muzaflargarh. Several fruit-growing associations are functioning successfully and have been instrumental in arousing a desire among their members for better orcharding, better marketing and better control of diseases and insect pests. It is reasonable to expect that these should later become important organisations for the rearing and distribution of improved strains of fruit trees. A large number of varieties of vines, oranges, grape fruits, mangoes, pomegranates, dates, olives, etc., are under observation and from the study of these, valuable information is being collected. One of the most important achievements in the fruit work in this province was the spraying of 12,000 fruit trees in the Kulu valley to overcome the harm done by the San Jose scale insect.

Research work carried out in the Fruit Preservation Laboratory at Lyallpur centered round the curing of dates, the drying of apple rings and the manufacture of by-products from various kinds of surplus or damaged fruits. An example of the latter was the manufacture of vinegar from unmarketable apples and from dates damaged by rains at the time of ripening. The wide-spread appreciation of this branch of the work is proved by the fact that the demand for admission to the fruit-growing and fruit-preservation classes was far in excess of the numbers that could be admitted.

In the UNITED PROVINCES, though a certain amount of interest in the growing of fruit trees is included in the activities of all the Government gardens in the United Provinces, the main work is concentrated at the Saharanpur and the Chaubattia orchards near Almora. Varieties of trees have been introduced from other provinces and from outside India, including citrus and guavas from Australia, loquat from Japan, olives from California and stocks of apples, plums and cherries from East Malling. The last have been budded and grafted with good varieties and planted out to test their suitability to Indian climate and soil. Included in these tests is a new variety of pear stock called *Pyrus calleryana*. Ex-

periments were carried out during the dormant season to destroy the woolly aphis which attacks fruit trees with such destructive effect and a certain measure of success attended the attempt to introduce the *Aphelinus mali*, a parasite, on this pest.

MADRAS. The fruits grown at Conoor were mainly plums, apples, quinces, persimmons, oranges, figs and guavas and 1,364 plants were distributed to growers. At Burliar and Kallar tropical fruit plants and spices were grown such as mangoes, mangosteens, guavas, sapotas, oranges, nutmegs, cloves and pepper. Efforts were made to increase the supply of grafted plants for which there is a growing demand and in 1931-32 1,268 plants were distributed.

In the CENTRAL PROVINCES, the demand for grafted mangoes and oranges is increasing year by year and hopes that concentration on this work will meet the growing demand seem justified. To test their capacity to fruit under the semi-tropical conditions of the Chindwara plateau, varieties of peaches, plums, pears, apricots, figs, lemons and oranges were planted some five years ago but though they flower well, they seldom set fruit and that not of esteemed quality.

At the BENGAL Government Farm and the Darjeeling Improvement Fund Fruit Nurseries, work is being done in propagating and distributing citrus, plums, pears, peaches, guavas, grenadillas, papayas, straw-berries, etc., and the number of cultivators applying for the fruit trees is gradually increasing every year. The cultivation of oranges and pineapples on the hills has expanded by leaps and bounds and every year thousands of such fruit trees and suckers are being planted.

In BIHAR AND ORISSA, in continuance of the procedure of the last few years, mango grafts of the choicest varieties were distributed and similar work has been done with lichies and guavas. For three years in succession, 1929 to 1931, though the mango has flowered profusely, the crop has been a comparative failure. At Sabour a record of the crop has been kept since 1920, and the three years 1923 to 1925 were also years of low crop. This problem of the intermittent bearing of mango trees is one of considerable

economic importance and an investigation of the various causes is being undertaken.

The appointment of an Agricultural Officer for BALUCHISTAN during the period under review will lead to further development of fruit culture in this administration. Work is progressing on grafting plums and peaches and 5,289 plants were distributed during the second year under report. Experiments were made on the control of insect pests, scale and aphids, and the results will be demonstrated in the near future.

Schemes for the intensive investigation of fruit problems are being prepared by the Departments of Agriculture in the Punjab, United Provinces, Bihar and Orissa, Assam, Madras, Bombay and Bengal for submission to the Imperial Council of Agricultural Research and, if adequate finances are forthcoming, there is a bright future for this aspect of horticulture.

13. Fodder Crops and Grasses.

One of the problems in the improvement of the live-stock of the country is the provision of more and better fodder in order to provide power in the working cattle, stamina in the young stock, and a better milk-supply. Rainfall is concentrated in a few months of the year and in the hot weather the temperature is in most places too high for growth. Improvement of the fodder crops by selection of suitable varieties and intensive cultivation so that they will provide a high enough yield to ensure a nourishing and ample ration for the whole year, is the problem before agriculturists. The solution is being sought in various directions as in the improvement of the grass of uncultivated areas, in the introduction and acclimatization of new fodder grasses, legumes and other plants, in intensive cultivation and in preserving the produce dry or as silage. The efforts and the measure of success that is being achieved in various parts of India will be described in the following paragraphs.

At PUSA, the cultivation of berseem (*Trifolium alexandrinum*) as a cold weather green fodder crop was continued in the low-lying

area of about 130 acres along the river side followed by maize and *meth* (*Phaseolus aconitifolius*) mixed in the hot weather by means of irrigation. During the season berseem required fifteen irrigations and maize and *meth* three. The cost per irrigation per acre by means of centrifugal pumps from the river was Rs. 2-2-6. A certain amount of green stuff was cut for fodder and silage and the rest of the crop was utilized for grazing. This area was brought under cultivation some eleven years ago and these crops have been grown continuously without any other manure than droppings of the cattle at the time of grazing. The exhaustive effects of this intensive cropping are now markedly visible as the yields of both berseem and maize have gradually decreased. In 1930-31 the yield of green berseem was 228 maunds per acre as compared with 468 maunds in 1923-24. Similarly the yield of green maize has gradually gone down from 300 maunds per acre to 159 maunds in the same period. It is proposed now to omit one maize crop every alternate year. A farm selection No. 1 white gave 169 maunds of green stuff against 117 maunds from the local maize in 1930-31 at Pusa, while at Lahore the same variety under irrigation gave 585 maunds of green stuff against 402 maunds of the local variety. This selection No. 1 gave 16 maunds of grain against 13 maunds for the local variety.

In BIHAR AND ORISSA, fodder crops received special attention on all farms. In addition to maize and *juar*, elephant grass (*Pennisetum purpureum*) and some varieties of sugarcane were found useful. Lucerne (*Medicago sativa*) when irrigation is available has proved to be of value. A strain of field pea, generally known as "Patna" pea, gave a very large yield of fodder especially suitable for dairy cattle. A mixture of Patna peas and oats cut green made an ideal feed for cows in milk though unfortunately its season is a short one. Many of these fodders are of limited application and what is required to improve fertility and to increase the cattle food supply, is the general adoption on a wholesale scale of suitable fodder catch crops after rice. *Khesari* (*Lathyrus sativa*) is grown to a certain extent but no greater improvement can be made than to get the principle of growing leguminous catch crops

generally introduced into village agricultural practice. This is the first step for a general improvement of fertility and for improvement in cattle conditions. It was proved at Pusa that berseem flourishes as well in Bihar as in Egypt. Few leguminous fodder crops give as high yields as berseem. Four to five cuttings or grazings may be obtained from October to April. Its only rival is lucerne which, however, is more of a garden crop. Berseem is a rotation crop of the highest value and produces fodder when fodder-supply is at its scarcest. One drawback is the fact that it does not produce seed in the Bihar plains. It is possible that it may do so on a practical scale at Ranchi and Netarhat. This is a very important point which is being investigated.

In BENGAL the Second Economic Botanist and the Livestock Expert have done much valuable work on fodders during these two years. Napier grass (*Pennisetum purpureum*) was the heaviest-yielding of all the fodder crops tried. It is perennial and propagated like sugarcane. Grown without irrigation, it gave 881 maunds per acre against 441 maunds from Guinea grass (*Panicum jumentorum*). Under irrigation at Dacca Sewage Farm, Napier grass gave 3,000 maunds per acre against 2,000 from Guinea grass. It seems possible that Napier grass will make an excellent permanent crop for a cultivator to grow near his homestead to furnish a perennial source of nutritious green stuff throughout the year. Early and late selections of *juar* (*Andropogon Sorghum*) from the Punjab and Bengal, respectively, were heavier yielders than Central Provinces types. Numerous American sorghum types were tried. As an early maturing, heavy-yielding fodder crop for green consumption or for silage, Kalimpong selections of maize were probably the best annual fodder crop. The public demand for good fodder is definitely on the increase, as indicated by the annual sale of nearly 4,000 maunds of green fodder at Rangpur and by the area put under fodder crops in the Nadia and Malda districts, where district live-stock officers were appointed two years ago. The next essential stage in development is the chemical examination of the various fodders with a view to comparing their respective nutritive values. The grant from the Imperial Council of Agricultural Research for entertaining a

Physiological. Chemist for three years will enable this work to be commenced.

Of leguminous fodders, cowpea (*Vigna catieng*) was better than *mashyem kalai* (*Phaseolus Ricciardianus*) on the red soil at Dacca ; but at Rangpur, on the grey silt, the reverse was the case. *Tonkola*, a type of *Mucuna utilis*, is a heavy yielder and a useful crop for bringing new land into condition.

Silage was made at all Government farms and an increased quantity by cultivators. Wherever the water-table does not come within five feet of the surface, pit silos were best. For places where pit silos were not possible an ordinary bamboo *gola*, as used for storing paddy grain, placed on a mound of earth, served to make excellent silage. Experimental manufacture of edible silage has been made from the following, at first sight unpromising materials : *aus* rice straw and water-hyacinth, *aus* rice straw and chopped banana stems, and similar combinations with sorghum. *Aus* paddy is of course reaped in the rains and often, on account of unfavourable weather, has to wait so long before drying that it rots or becomes mouldy and useless as fodder. Making *aus* rice straw into silage opens out the possibility of saving a great deal of valuable fodder.

In ASSAM, fodder crops are grown at the Upper Shillong Farm as a rotation with potatoes. The main crops are maize and local *raishan* (*Paspalum sanguinale*), the former being made into silage and the latter into hay. There is also need of a legume in the rotation and many have been tried, such as soy beans (*Glycine hispida*), lucerne, clover and cowpeas without great success. The local or Khasi *matai-kalai* has hitherto been found as good as any of these, but a further trial of lucerne and cowpeas is being made. *Paspalum dilatatum* (the famous "blue-grass" of Australia and Kentucky) does well on this farm and has held its own against local grasses without assistance for many years. An attempt is now being made to extend the area. At the Jorhat Farm experiments in making silage from the wild deep-water paddy and also from a mixture of dry paddy stubbles and plaintain stalk, chopped

and sliced, in equal parts by weight, have given excellent results and are sure to be of immense value to meet the fodder difficulty.

In the NORTH-WEST FRONTIER PROVINCE *shaftal* (*Trifolium resupinatum*) has been grown for more than half a century but berseem, which was introduced in 1911, has gradually been replacing it and now it covers a greater area than *shaftal*. It yields an earlier cutting and a considerably greater weight of fodder and is less inclined to induce Tympanitis in cattle. No disease or insect pest has yet afflicted this crop in the province. Chicory, however, was abundant as a weed in some places and the department has tried hard to induce the cultivators to pay more attention to harvesting a pure crop.

PUNJAB. *Kharif fodders*. In the PUNJAB, a trial to compare the yields of green fodder from crops commonly grown during the *kharif* was conducted. The test included Sudan grass (*Sorghum sudanense*), Sudan grass and cowpeas mixture, *juar*, *juar* and *guara* (*Cyamopsis psoraloides*) mixture, maize, maize and cowpeas mixture and *maran* or indigenous cowpea. The result showed that in the first cutting maize alone and maize and cowpeas mixture in all cases, and also *jowar* and *guara* in some cases, gave the highest yields, but Sudan grass out-yielded all other fodders in the total of two cuts. Considered as a fodder plant, Sudan grass is one of the best on account of its leafiness and its ability to supply a large bulk of green fodder well distributed over the year. A further experiment to investigate the result of repeated cuttings on the seed-setting powers of Sudan grass showed that the uncut crop gave the highest yield of seed. The crop cut once gave a much reduced seed yield, whilst the crop cut twice failed to mature any seed, although the flowering appeared to be normal.

Elephant grass continues to increase in popularity by leaps and bounds. The Fodder Specialist's Section provided 100,000 planting sets to zemindars during the year against 30,000 in the previous year and even then many applicants had to be turned away disappointed. Its heavy yield and continuous supply of green fodder throughout the year are gaining for it a high place amongst the fodder crops in the province. Detailed studies were made of a

large number of single head selections of indigenous *juars* and mass selection work was carried out on the standing crop. The best yielders are under further trial. Cowpeas were tested for fodder yield at Lyallpur and various other places. Two-hundred-and-fifty maunds per acre of green fodder were obtained at Lyallpur, while at Kangra the yield was 300 maunds. Cowpeas is a very nutritive fodder and is likely to become very popular in the future. A large number of requisitions for seed was received. Various strains of hairy and non-hairy *anjan* grass (*Pennisetum cenchroides*) were under trial for the purpose of obtaining data as to the herbage produced during the growing period under a system of repeated cuttings. The yields fell gradually after each cutting but the percentage of leaf rose and on this account the palatability and nutritive value of the grass improved.

Rabi fodders. Fifty selections of *Senji* (*Melilotus parviflora*) made from the previous year's crop were under study, whilst the progeny of 130 single plant selections of *metha* was under experiment. Further trials carried out with five types of rapes confirmed the results obtained in the previous year that the Japan white-leaved rape produces the highest yield of fodder. Thirteen varieties of oats from New Zealand, five from Algeria and sixteen from local sources were under study. Two of the New Zealand types produced tall and heavy-yielding crops. Another New Zealand type, almost equally good, had the additional advantage of remaining green much longer than the others. Algerian oats were tried for the first time and appear to be promising, both as regards quality and quantity of fodder produced. They appear to mature late—about the middle of May—and may prove to be a possible source of green fodder late in the season. Further tests remain to be carried out on all these varieties. Following on the Fodder Specialist's examination of the grasses in the lower Murree Hills, work was commenced in collaboration with the Forest Department on the improvement of hill forest grazing areas. Both berseem and *shaftal* have been tried under well irrigation, sown immediately after rice. When sown in the standing rice crop they did very poorly, but when sown by breaking the land after the removal of the rice crop they did

well, giving 5 cuts and yielding at the rate of about 490 maunds of green fodder per acre in the case of berseem and 750 maunds per acre in the case of *shaftal*. Egyptian farmers got a very important part of their winter fodder by growing berseem after rice, and this experiment was started in order to see whether Punjab rice farmers could also benefit in a similar way.

In the UNITED PROVINCES, interesting experiments have been made with the various kinds of fodders grown on the cattle farms. The results with sunflower (*Helianthus annuus*), both in the green state as well as silage, have been particularly satisfactory, and it can be recommended to all cattle-owners who want a supply of green fodder during the cold weather. Satisfactory results were obtained also from Guinea grass (*Panicum maximum*), Elephant grass (*Pennisetum purpureum*), and the high yielding indigenous variety called *rata* grass (*Anthistiria ciliata*). The latter makes excellent silage and is relished by the cattle. Various other fodders, such as Sudan grass, Wimmera rye grass, cocksfoot, subterranean clover, Italian rye grass, Timothy grass and also broom corn were tried. The results, however, have been poor and do not justify further trials being made.

In the CENTRAL PROVINCES, the question of fodders and grazing has continued to receive attention and the suitability of selected strains of *sheora* (*Alysicarpus rugosus*) and soy bean (*Glycine hispida*) as forage crops to supplement ordinary grasses has been confirmed. Fairly complete information is also now available regarding the botanical nature and agricultural possibilities of practically all the grasses occurring in the province. It is worthy of note that only the indigenous grasses deserve consideration and by re-seeding, rotational grazing and fencing, grass land can be effectively improved. In conjunction with the botanical work, determinations of the nutritive value of the commonly occurring grasses have been continued and in view of the low feeding value which such analysis often indicate, the effect of various manures upon the quality of pasture grasses has been studied. This work will be given more permanency by laying out replicated plots on the Telinkheri Farm.

The research on grassland was continued by the Economic Botanist, BOMBAY. At Bhamburda, the system of rotational grazing using four ten-acre blocks and 20 cattle was continued. From each ten-acre block grazed this year two acres were fenced off and the grass cut in order to estimate the amount of feed produced and thus judge of the effect of the treatment. The animals were in healthy condition throughout the year and increased in weight till the end of December. There was some falling off of weight thereafter, but this was retarded when silage made from the grass of the area was fed to them during the hot weather. This silage was made in a silo pit excavated on the site, the amount of grass put in being 24,000 lbs. No other food except grass grazed or stall-fed as hay or silage has been given to the animals. The vegetation of the Bhamburda area continues to improve. Construction of contour bunds has helped a good deal in checking soil-erosion and increasing the plant population. This experiment will terminate on December 31, 1931. It is gratifying to report that the Forest Department are prepared to try out these methods on a large scale in a grazing area under their control near Poona, and at their initiative a scheme is now under consideration for applying the principles of rotational grazing to an area of land in their control. If this materializes and proves successful, then the co-operation of the Forest and Agricultural Departments will have gone a long way towards solving the problems of prevention of erosion, improvement of forest grazing lands and better nutrition of cattle, all of which are inextricably bound up with one another. At the Cattle Farm, Chharodi, 240 tons of hay were made in 1929-30. Hay-making by machinery has progressed considerably; the cost has been reduced to two rupees per 1,000 lbs. Next year, however, half the standing crop was sold as this farm had a big store of hay. In tests carried on for several seasons, it became evident that the local *jowar* was superior to all other varieties, that maize and *bajri* did not compare well with it, and that pulses with the exception of *chavli* (*Vigna catianga*) did not yield well and were too expensive to grow and watch against wild animals. Elephant grass and berseem were experimented with.

In SIND, experiments are being made with berseem, oats and soy beans. It is hoped that, as berseem is *kalar*-resistant, it may be useful in solving the problem of reclamation of saline land.

In the north-eastern part of MADRAS, sunn hemp is the most important fodder crop. It invariably follows the rice crop and is usually cut when it is in full flower and made into hay. It may yield 240 maunds of green stuff per acre but when rice is lodged, however, as it was in 1930-31 after a cyclone during harvest, the sunn hemp crop is poor. A quick-growing wild plant, *Phaseolus trilobus*, is gaining ground as a fodder crop and is increasing rapidly in the deltas. In Chittoor and Coimbatore districts sorghums were the popular fodder plants, the variety called *kaki-jonna* giving 208 maunds of green fodder.

At Koilpatti, manurial trials with ammonium sulphate and groundnut-cake in conjunction with superphosphate on fodder sorghums and *Pennisetum typhoideum* were made. In the first year striking increases in yield were obtained but in the second year differences were not so marked. Ammonium sulphate proved superior to groundnut-cake. Selection work on fodder sorghums was started in 1930-31 at this station.

Various grasses like Guinea grass, Elephant grass and *kohu-kattai* grass were being taken up in some places. On the hill slopes large quantities of green grass are available after the rains. A certain amount is cut for thatching purposes when it is dry and the rest dries up and becomes waste. On the advice of the department, some of the ryots prepared silage from this hill grass when it was green, and fed their cattle during the hot weather when succulent fodder was scarce. The silage prepared was good and the cattle relished it well. The Systematic Botanist was engaged on the survey of grazing areas in the departmental farms and in several districts. One hundred-and-seventy species of grasses were collected and were being analysed by the Agricultural Chemist with a view to estimate their feeding value.

The fodders of BURMA are *jowar* in Upper Burma and rice straw in Lower Burma. Burmese *jowar* is of two kinds, the red-seeded *jowar* in which the seed is of inferior eating quality and which is

used mainly for cattle food, and the white-seeded variety of which the seed is an important article of food in parts of the dry zone districts. The seed of this crop is often badly attacked by smut but during the years under report the crop was fairly free from this disease. In addition, at Tatkon, Saccoline, an Australian variety of *jowar* is also grown. Merkers grass which is also a useful introduction gives a continuous supply of fodder throughout the year except in the three dry months February to April. On the Mandalay Agricultural Station, berseem and lucerne were grown, the former being broadcasted in the standing crop of paddy and allowed to grow after harvest and the latter being sown on raised beds as an irrigated dry crop. These two fodders serve a useful purpose where dairy cattle are kept but they cannot be introduced into the general economy of the dry zone, where *jowar* continues and appears likely to continue to hold the first place as a food for working bullocks.

14. Millets.

The principal millets cultivated in India are *jowar* (*Andropogon Sorghum*), *bajra* (*Pennisetum typhoideum*) and *ragi* (*Eleusine coracana*) and they occupy together an area of about 56 million acres. Of these *jowar* is by far the most important, occupying as it does, 33 million acres, an area larger than that of wheat. *Bajra* comes next with 13.5 million acres and *ragi* has nearly 6.5 million acres. Several other millets are of importance locally but are not important enough to be reported separately.

Jowar. The area under *jowar* was 30.9 million acres in 1928-29. It increased by 7 per cent. to 33.2 million acres next year and was 33.1 million acres in 1931-32. The chief *jowar*-growing areas in order of importance lie in Hyderabad, Bombay, Madras, Central Provinces, United Provinces and the Punjab. It is also cultivated as an important fodder crop in most agricultural areas in India. In two provinces, Madras and the Punjab, Millet Specialists are in charge of the work of development.

In HYDERABAD STATE which has twenty-nine per cent. of the total area in India, selection work was begun at the Experimental

Farm, Parbhani, which is mainly devoted to wheat and *jowar*. Already one dwarf and one tall variety have done well.

BOMBAY has 28 per cent. of the total area under *jowar*. The most promising type for the Surat area was Budh Perio No. 53. At the Surat Experiment Station 70 acres laid down to this variety gave an average yield of 883 lbs. per acre. In properly replicated tests this variety has given for the last five years on an average 19 per cent. more grain than the local variety. At Mohol work on selection of high-yielding strains of Maldani and Dagadi progressed. These two varieties continued to give good results and were spreading in West Khandesh as a *rabi* crop. The advantages to be obtained by the grading of *jowar* are becoming widely appreciated. This is a very simple operation which can be done by hand-sieves. In Barsi Taluka of Sholapur district 13 villages have adopted the method wholesale, and as a result of propaganda in Sholapur district 544,526 lbs. of *jowar* seed were graded, of which the department directly graded about one-half. This is exclusive of the grading done by private persons and co-operative societies. The average increase in yield of the *jowar* crop, from graded seed, distributed over a large area, was 32 per cent. in the case of the grain and 15 per cent. in the case of the straw. At the Dry Farm at Manjri, where Kalbondi, a variety of *jowar*, is the most important crop, experiments were carried on regarding bunding, mulching, manuring and cultivating, and valuable results were obtained which are being actively demonstrated to the cultivators of the dry zone.

Approximately five-and-a-half lakhs of acres are cultivated annually in SIND under *kharif jowar*, largely in the northern districts. Under perennial irrigation from the Lloyd Barrage and Canal Systems, a considerable increase in this area must be anticipated in view of the increased demand for grain for human consumption and of fodder for work animals. There are about fifty-five different varieties of *jowar* in Sind and all of these have been grown at Larkana and at the Agricultural Research Station, Sakrand, where a detailed scientific classification of the crop has been made. As a result of selection from this material, several varieties have been obtained which are outstanding for high yield and hardiness and

improved strains of each of them have been evolved. These selected strains—Saoro Kartuho No. 1, Bagdar No. 1, Red Janapur No. 3—yield from 20 to 40 per cent. higher outturn than the ordinary crops now in cultivation in Sind and seed is being multiplied by departmental agency as rapidly as possible for further extension in the districts. Three American varieties of grain *jowars* were tested but did not approach the local improved varieties in point of yield. Hybridization work is also in progress and attempts are being made to impress the character of heavy weight of grain possessed by a local variety, named Torh, on the selected high-yielding strains evolved by the department.

In MADRAS, where 15 per cent. of the area under *jowar* is situated, the improved strains already introduced in the Deccan are T1 and T6, and in the two years under report 4,360 and 11,280 lbs. of pure seed were distributed. A new strain N. 23/10 is likely to replace the older strains. A yellow strain A. S. 809 and a white strain A. S. 1543 seemed best suited to Coimbatore, and in 1930-31 when the season was most unfavourable to *jowar* they still gave a better yield.

Bajra. The total area reported under *bajra* is about 16 million acres but though reports are not received from all areas, the figure is not far short of the actual total. The chief *bajra*-growing provinces are Bombay, the Punjab, Madras and Bihar and Orissa. In BOMBAY, selection work has been going on for many years and several selections are already established. Akola *bajra* was popular and was being appreciated in other districts as well. To meet the demand for pure seed about twenty-two thousand lbs. were distributed in the period under review. Three new races tested against the Akola variety showed improvement. As was the case with *jowar*, seed-grading was found to be profitable. Both in the PUNJAB and the CENTRAL PROVINCES selection was in progress and some strains look as if they are going to replace existing strains; indeed at Akola, two strains are already replacing the local variety.

Ragi. *Ragi* is grown on an area of about 6.6 million acres of which Mysore and Madras have one-third each and Bombay and Bihar and Orissa have most of the remainder. As *ragi* is the most

important single crop in MYSORÉ, much attention continued to be devoted to it both at Hebbal and Hunsur. Three strains H. 2, H. 22 and H. 40 have now been widely distributed and nine of the more recent selections showed themselves superior to the local variety even under the trying conditions that obtained in the season 1929-30. A number of newer selections have become available for multiplication and some have been distributed for trial. In MADRAS this crop has been studied intensively at Coimbatore in the south and Anakapalle in the north. The strain E. C. 47 has proved to give a higher yield than the old improved strain T. 8 evolved at Hagari but as it matures later, it requires more water. There is some hope, however, that another new strain E. C. 593 which matures a week earlier will be more suitable. Strain No. 525 looks as if it would replace local *ragis* in the northern area. To test whether *ragi* can be grown throughout the year, a seasonal experiment has been started with one long and one short period variety. In the KONKAN in BOMBAY four strains A. 16, B. 11, E. 31 and E. 82 that proved superior to the local varieties were distributed to registered seed-growers.

At Kalimpong in BENGAL selection work was also in progress and one type No. 46 promises to be a good yielder.

15. Other cereals.

Maize is grown in about six million acres of which about two-thirds are in the United Provinces, the Punjab and Bihar and Orissa. In all these provinces, selection is now being carried out but as this crop takes a long time to improve, none of the selections are yet ready for distribution. At PUSA, 12 selfed lines in the white-seeded race and 15 in the yellow-seeded have been under study for the last 4 and 5 years, respectively, but none has become pure yet. The work of getting them pure by in-breeding will take 2 or 3 more years. In BIHAR and ORISSA a selection that showed promise of being better did not come up to expectation. In the UNITED PROVINCES, Jaumore maize continued to be popular and Peshawar white maize continued to be the most suitable variety for rotation with wheat in the NORTH-WEST FRONTIER PROVINCE.

Barley. Barley is grown on about 7 million acres, two-thirds of which are in the United Provinces. The exports of barley have declined almost to vanishing point during the last two years from 138,000 tons in 1928-29, which was a year of abnormally high export, to 6,000 tons in 1929-30 and 100 tons in 1930-31. The price declined from Rs. 34 per candy of 656 lbs. in 1928 to Rs. 20 in 1931. A classification of nineteen types of 6-rowed barley and five types of the 2-rowed variety together with a study of the root-system of most of them was published in the *Indian Journal of Agricultural Science*, I, Pt. I. Yield trials with the four best types, T. 21, 20, 12 and 7, were made in both years under review and the yielding capacity was in the order named. Type 21 has been tried in several places. At Makrera, Rajputana, the yield was 2,152 lbs. per acre, at Dholi 3,845 lbs. and in Pusa 2,570 lbs. and at Shahjahanpur 2,683 lbs. per acre. Rather an interesting point arose out of this trial in that the results suggested that T. 21 utilized borders to a greater extent than the other three types, probably by virtue of its greater tillering and standing capacity. In an estimation of the malting value, T. 20 had a high diastatic activity while T. 21 was rather low. During the year 1930-31, 4,358 lbs. of Type 21 were distributed for trial.

UNITED PROVINCES. Two of the new strains isolated in 1927 were found to be promising and seed was distributed to compact areas in order to elicit the opinion of the grower. In a varietal trial at the Shahjahanpur Research Station, these two varieties, B. 251 and 255, gave an yield of 38 to 39 maunds per acre, while the other Pusa varieties tested with them gave 32 to 34 maunds. B. 251 has proved to be the best both in yield and quality. Samples were sent for examination by experts of the Institute of Brewing, London, and favourable reports have been received.

BIHAR AND ORISSA. For the last four years in Bihar and Orissa Pusa B. 4 proved to be very much superior to local varieties and 500 maunds of seed were released to growers.

Oats. The Pusa selected types B. S-1 and 2 are still in demand among Bihar planters and others. Some better strains evolved by hybridization of these oats with the Scotch Potato and the Abun-

dance varieties, respectively, show definite improvement in the plumpness and yield of grain and the profuse quantity and strength of straw.

Though in small-scale trials the types B. S-1 and 2 gave greater yield yet in a large-scale yield trial, when forty balanced strips each half an acre in area were sown alternately with the two varieties B. S-1 and P. F-1, a farm selection, the difference in yield was not statistically significant. The large-scale trials will be repeated. In a field trial B. S-1 was tried against a Lyallpur strain and found to be a little less susceptible to smut.

16. Potatoes.

The work on potatoes in all provinces in which they are grown was confined to testing varieties, manuring, storing and distributing acclimatized tubers. Only in the Punjab and Bengal has an attempt been made to select new strains from seed. In the former province crossing has been tried but without success so far, on account of the fact of the almost complete absence of viable pollen.

Varieties. In the PUNJAB, as has been the case for several years, the various Scotch varieties gave much higher yields than local types in the Simla hills. On the average of a large number of experiments, these varieties yielded about forty maunds more tubers per acre than the local varieties and were of better quality and size. Based on the price at the time of harvest in 1931 of Rs. 2-8-0 per maund, growers of the improved varieties had a net gain of Rs. 100 per acre. Certain English varieties and five of the nine new Scotch varieties all of which were introduced recently also showed considerable promise. Similarly on various farms in the plains certain of the imported varieties taken from the hills have proved distinctly superior to the local varieties. In the UNITED PROVINCES, which have an area of 153,500 acres under potatoes, at the Potato Research Farm at Farrukhabad, it has been found that "seed" from the hills gave far better results than that which is saved from the crop in the plains and an attempt is being made to organise the supply of hill-grown "seed," so that sufficient quantities may become available to agriculturists in the plains at the proper time.

Already for the plains of BIHAR and BENGAL " seed " is brought from the hills around Darjeeling and Shillong. The potato is an important crop in the Southern Shan States of BURMA. A few of the introduced varieties are now widely distributed, the most important being Up-to-Date, Ally and Great Scott. A summary of the information regarding this crop was made in 1931 and published as Agricultural Survey No. 10 of the Burma Department of Agriculture.

Storage. In all parts of India where potatoes are grown difficulty is found in storing them from the time they are lifted from the ground till the time of replanting. Losses due to rotting in ordinary methods of storage as practised by the cultivators and merchants always occur and they often run between 30 and 50 per cent. of the crop put in store or even higher, and this loss is a limiting factor in the extension of the crop. Rotting is mainly due to the attacks of bacteria, *fusaria* and insects, especially the potato moth *Plthorimaca operculella*, and experiments to try to find a simple method of reducing the losses were carried out in every province and State in India where potatoes were grown. In the UNITED PROVINCES a cold storage method has proved to be effective but it is available only to big merchants and can have no general utility. However, a simple and effective method has been devised to reduce the loss caused by the potato moth which here does most damage, and consists in covering the potatoes with sand immediately after harvesting and at intervals passing the sand through a wire gauze sieve in order to remove the pupae. The moths that come out of infected tubers were found to pupate in the sand. In an experiment in 1931 at the Research Farm, out of 190 maunds of potatoes stored for seed only 9.5 per cent. rotted, including the quantity discarded before storage, because of primary infection and also wet and dry rots. The solution of the problem is also being sought in the form of an earlier maturing variety which is being acclimatized by growing it alternately in the hills and the plains. In the PUNJAB, the continued study of the behaviour of potatoes stored in an under-ground chamber shows that while the temperature of the chamber is generally about 80° F. and is beneficial for storage,

the humidity remains as high as 96 per cent. As a result of this excessive dampness the advantage gained from the low temperature is lost to a great extent. Even with this disadvantage the percentage of loss due to decay in this chamber is considerably less than under ordinary storage conditions. In the latter case the loss during the year was as high as 90 per cent., whilst in the former it was about 42 per cent. Another advantage of storage in a chamber of this kind lies in the greater germinating power of the seed. With a suitably designed chamber, provided with ventilation and giving a temperature of about 80° F., combined with a low humidity, the loss due to rot should be minimised considerably and the germination capacity should be much higher than in the case of potatoes kept under ordinary methods of storage in potato-growing districts. At Nagpur in the CENTRAL PROVINCES, storage experiments showed that during the hot weather potatoes could be saved at a very small cost and without any appreciable loss but during the monsoon months the loss was considerable. At PUSA, DACCA and SHILLONG experiments on treating potatoes before storage with various chemicals did not meet with much success.

In the PUNJAB, another line of investigation for overcoming losses during storage so far as "seed" is concerned is to take hill potatoes immediately they are harvested to the plains and plant them there on arrival, but such seed potatoes harvested in the Simla Hills in September do not germinate satisfactorily if planted in the plains in October. With a view to accelerate the changes that take place during storage, freshly-lifted potatoes have been subjected to a number of chemical and physical treatments. By a combination of chemical and temperature treatments all the potatoes were made to sprout within three weeks after treatment. Field trials with the treated and with untreated potatoes were being carried out at Mashobra but the results are not yet available.

Manuring. In MADRAS, a mixture of fish guano, super-phosphate and muriate of potash has given higher yields and the growers in the Nilgiris are using artificials in increasing quantities, while in ASSAM artificial nitrogenous manures gave great promise in the Khasia hills.

Mosaic. After roguing mosaic plants for three successive years, the crop which originally had an infection of 70 per cent., both on the farm at Farrukhabad and elsewhere, was free from the disease. In the PUNJAB too this was being done with some success.

17. Beans and Pulses.

This group of crops is important from every point of view. As rotation crops they are intimately concerned with the maintenance of soil fertility ; for a population which is largely vegetarian they form an article of diet of primary importance ; they provide part of the concentrated food for working cattle and certain pulses are an important item of export. If falling prices for cereals and fibre crops, coupled with the use of higher-yielding varieties of these crops (thus maintaining the same standard of production on a smaller area), leads to an increase in the area under pulses, the eventual gain to the agriculture of the country might be considerable.

Gram. One of the most important of the pulses is gram *Cicer arietinum*. The area under this crop in 1928-29 was 14,951,000 acres, in 1929-30, 13,245,000 acres and in 1930-31, 12,399,000* acres, but taking Hyderabad figures which are not yet available for 1930-31 to be the same as those in 1929-30, *i.e.*, 1,106,000 acres, the total for 1930-31 would be 13,505,000 acres. With 5,424,000 acres the United Provinces has the largest acreage and the United Provinces, Punjab, Central Provinces and Bihar and Orissa have between them 76 per cent. of the total area.

So far the recorded area under improved varieties was about 1.5 per cent. of the total area and of this 75 per cent. is in Burma. As most provinces include the area under improved kinds of gram under other crops, the true figure for this crop cannot be found but it must be comparatively large.

At PUSA the description and classification of the 59 new and 25 old types was revised and published in 1930. The study of some crosses made in past years indicated that the general constitution of the white flower was not the same in all white-flowered types

* Incomplete.

and that the pink colour in the flower resulted from the interaction of two factors, one of which produced blue and the other modified this blue to pink. The gigantic mutant Type 79 compared with its original Type 24 showed that there was an increase in the size of the cells, in the number of layers of various tissues and in the number of chromosomes.

The UNITED PROVINCES is the premier gram-producing province in India. The two chief varieties grown are two Pusa types, and the department supplied 10,000 lbs. of pure seed in 1929-30 and 11,500 lbs. next year. Selection of pure varieties and hybridization with a view to evolve a hardy prolific variety was also in progress.

In the PUNJAB the three best types of gram Nos. 7, 15 and 17 out-yielded the local sorts in the three areas for which they are most suitable. 365 maunds of pure seed were distributed in 1930 for sowing the next year's crop. In 1930-31 a new type No. 19 out-yielded all the other varieties and showed promise. Gram blight is under study.

In the CENTRAL PROVINCES samples of grams were collected from all over the province and selection was begun. Wilt caused severe loss here and a recent selection No. 515 has proved to be wilt-resistant and will be utilized to impart resistance to other strains of higher cropping power. The three wilt-resistant samples of gram from Poona and Cawnpore were poor yielders in the Central Provinces, but they will be used also for the production of profitable wilt-resistant types.

In BIHAR AND ORISSA the results of the yield trials of Sabour 4 and Pusa No. 17 for the past 4 years pointed to the decided superiority of the Sabour selection for South Bihar conditions. Some of the hybrid grams superseded the existing gram types both in yield and quality. Generally, size of gram went along with lower yield but in the hybrids some seemed to be capable of giving a good yield combined with large, bold, coloured seed. They need to be further tested before they can be supplied to the departmental farms. The study of the genetics of this crop was in progress and useful information regarding the inheritance of quantitative and qualitative characters has been recorded.

In BURMA about 70 per cent. of the area grown was under improved varieties. In 1929-30, 1,420 maunds of pure seed were distributed and in 1930-31, 1,940 maunds. The Karachi gram, introduced by the Department of Agriculture about 10 years ago, still maintains its superiority and has replaced the Burma variety. A disquieting report that in some localities it is beginning to show signs of wilt is being investigated, and selection of the Karachi gram was undertaken.

In BENGAL Sabour 4 and Pusa 18 were the two leading varieties. Though the former is about two weeks earlier the cultivators prefer it. The classification of Bengal gram was completed.

Pigeon Pea. At PUSA varieties of pigeon pea were classified and described. Two of the types with a spreading habit are highly wilt-resistant and a hybrid as well. Work was in progress to combine erect habit with wilt-resistance. In BURMA a new strain C. 10, free from the condition known as "green ear" and with a shorter growing period, has found favour with the cultivators. In BIHAR AND ORISSA, among the erect varieties Sabour 2-E proved to be the best yielder and was far superior to all the erect Pusa *rahars*. As regards the spreading varieties, one Pusa type and Sabour 7-S. were equally good. The observations of the last three years have established that a few types are resistant to the "sterility disease". Particular attention was paid to erect types because, when grown in rows, cultivation may be done by means of bullock hoes. In the CENTRAL PROVINCES a description of types of *rahars* in the province has been published. Only early-ripening types do well here and the best having regard to yield, quality and flavour was Type 8 No. 3 and there was a considerable demand for its seed. Here too attention was directed towards obtaining wilt-resistant strains.

Peas. At Pusa and at Sabour in Bihar and Orissa, the isolation of unit types of both *Pisum sativum* and *P. arvense* was in progress. At Pusa and in Bengal the same was being done for *urid* and *mung*, *Phaseolus radiatus* and *P. mungo*, also for lentils (*Ervum lens*, Linn).

In Burma too work on *urid* and *mung* was in progress and selections were tried out in some of the farms.

Beans. The main work on pulses in Burma centres on the introduction of the new Burma butter bean which promises to be a valuable addition to the agricultural economy of the dry zone. This is a variety of *Phaseolus lunatus* which was obtained in a small sample from Egypt some six years ago. It has since been selected to give a yield corresponding to that of the indigenous Rangoon white bean from which it is scarcely distinguishable in the field. The seeds, however, of the butter bean are larger and flatter and of much better cooking quality than the former. Work with this bean consisted in multiplying it for the purpose of providing experimental shipments and also to produce pure lines of the type which the trade in Europe seems most to demand. Some of the seeds have a yellow colouration which reduces the value of the bean and it has been found that this can be eliminated by pure line cultures which do not contain this colour. Selection work continued at the Mahlaing Agricultural Station where ten single cultures selected last year were compared against each other. One was found to be the best all-round strain. At the Tatkon Agricultural Station it was found that the application of the fertilizer nicifos not only had no effect on this bean but actually depressed the yield. Spacing experiments were also done which proved that $2\frac{1}{2}$ by 3 feet is the most satisfactory spacing. A large number of single plant selections were also made for further examination and test. In 1929-30, through the Burma Chamber of Commerce, twenty-two tons were sent as a trial consignment to London, where it realised £22-10-0 a ton when Rangoon white bean was selling at £14-10-0. Next year a shipment of twenty tons was made and the price obtained was £20 per ton against £10-10-0 for Rangoon white bean. The department considers that it should adopt a conservative policy and maintain control over the cultivation of the bean till such time as a market has been established.

CHAPTER III

RESEARCH AND INVESTIGATION.

In the summary of economic work on crops, given in the previous chapter, reference has been made to a good deal of research work in progress particularly in economic botany. In this chapter an attempt is made to refer briefly to the research work on the more important problems in the different branches of agricultural science and to some of the results obtained. More detailed information will be found in the *Scientific Reports of the Imperial Institute of Agricultural Research, Pusa*, and in the reports of the research officers of the various provinces and States.

1. Soils.

Surveys. Soil-surveys of the Pegu district and of the Mandalay canal area in Burma, of the areas under the Haveli project and of the three extensions of the Lower Chenab canal in the Punjab, were made. A geological and agricultural survey of an area of 70,000 acres under the Irwin canal in Mysore was practically completed, showing particularly the areas suitable for sugarcane cultivation. The survey of Jorhat in Assam was in progress.

Base-exchange. In MADRAS a systematic study of the important types of South Indian soils for the nature and amount of replaceable bases was begun. As a preliminary step, a method suited to calcareous soils has been evolved, which consists in using for extraction a mixture of sodium carbonate and sodium chloride at a pH of 7.8. The application of sodium nitrate to swamp paddy soils up to a maximum of 3 cwts. per acre per annum continuously for five years did not induce alkalinity, but the irrigation of garden soils with well water containing large amounts of sodium salts interfered with the soil complex producing harmful results. The extent to which sodium can be allowed to enter into the soil complex and the safe limits of the range of the lime-soda ratio were under investigation. Examination of a number of paddy soils from Coimbatore, Aduturai and Godavari showed that they are un-

saturated. This appeared to be the result of a swamp system of cultivation, involving the leaching of the soils continuously with water saturated with carbonic acid gas or from the nature of the manures used. It was found that the continued use of ammonium sulphate, superphosphate and potassium sulphate, singly or in combination, changed the cationic composition of the soil clay. Superphosphate produced the least change, potassium sulphate produced the most. In mixtures the action of each fertilizer was independent. With ammonium sulphate, lime replacement was even less than in the manured plots. The following explanation was offered. The soils have sufficient supplies of calcium carbonate and, therefore, the nitric acid resulting from the oxidation of ammonium sulphate would dissolve lime and maintain its concentration in the soil solution and set up a reaction in the reverse direction ; this helped to maintain the lime status of the soil. The status of the soil under continued use of ammonium sulphate is therefore apparent and not real and it should not be interpreted that no lime depletion occurred. The exchange reaction being instantaneous, lime depletion does occur immediately the soil comes into contact with a solution of ammonium sulphate, but later on the nitric acid resulting from the oxidation of the ammonia brings more lime into the soil solution, and sets up a reverse reaction thus maintaining the lime status of the clay complex.

The determination of replaceable bases in BURMA soils was continued using Hissink's method, and a large number of soils in the Pegu and Mandalay canal area were completed. In addition, an electro-dialysis method for extracting replaceable bases from soils has been investigated and promises to be an improvement on the methods depending on treating soils with either neutral salts or dilute acids, inasmuch as the resulting solution is much easier to analyse since it contains the bases as hydroxides uncontaminated with large amounts of sodium or ammonium chlorides which are difficult to remove, particularly for estimation of potassium and sodium.

In BIHAR AND ORISSA the problem of acidity of the soils of Chota Nagpur and parts of the deltaic region of Orissa was investi-

gated, as well as the changes in the soil reaction and the amount and character of exchangeable bases due to continuous manuring with certain fertilizers. Permanent plots have been laid down in the Kanke, Ballia and the Cuttack Farms and experiments are in the second year. The coastal area is at times flooded by sea water raised by high winds and the irrigation water itself is sometimes saline. There the condition of the land is damaged in texture and the *gur* made from sugarcane has a salty taste. The effect of lime and gypsum in excluding sodium salts by base-exchange in the soil is being investigated.

Mechanical analysis of soils. At the DACCA UNIVERSITY three existing methods and one new method of mechanical analysis were tried on a number of samples of lateritic soils, two from Dacca and four from the districts of Hazaribagh and Santhal Parganas in Bihar, in order to find which method gave the maximum dispersion. The methods tried were: (1) the International method but without the peroxide treatment since lateritic soils contain little organic matter, (2) the sodium chloride method as developed by Dr. Puri, (3) the sodium carbonate method as developed by Dr. Joseph but using the pipette technique in place of sedimentation and (4) the sodium hydroxide method in which an attempt was made to disperse the soil with a small dose of sodium hydroxide without the previous sodium chloride treatment as in (2) or the acid treatment as in (1).

In addition, four more Dacca soils were analysed by (1) and also by (2) and 14 other Bihar soils by (2). Complete analyses were made in all cases. Both the International and sodium chloride methods dispersed all the Dacca soils practically to the same extent, but in the case of two out of four Bihar soils the amount of clay obtained by the latter method was distinctly greater. There was also a loss by solution of soil materials to the extent of about one per cent. as a result of the acid treatment in the International method. On adopting a much longer period of shaking in either method, no gain in the amount of clay or clay plus silt was obtained. This shows that in the case of lateritic soils the maximum dispersion was obtained by the prescribed treatment for each

method. In all cases the sodium carbonate and sodium hydroxide methods gave much smaller amounts of clay than did the other two methods. The lower dispersion with sodium hydroxide is believed to be due to the fact that the amount of alkali added was insufficient to convert the whole of the clay into sodium clay. But this was not so in the case of sodium carbonate method.

In **BENGAL** the results of a comparative examination of methods of mechanical analysis of typical Bengal soils indicate, contrary to expectation, that the laterite alluvial soils of the Bharind and Bhowal jungle tracts present no difficulty in dispersion but that soils containing considerable percentages of lime, mica and organic matter may offer greater difficulty.

In **MANDALAY** some 210 Burma soils from three distinct tracts have been examined for percentage of clay, air-dry moisture, loss in ignition and moisture at sticky point and the correlations worked out. The conclusions are at variance with those obtained by Keen and Coutts in similar studies.

Soil-acidity and lime-requirement. The deep alluvial soils of **SIND** vary very much in their character from place to place. Further tests of the soils at different spots on the farm showed that the pH value of the soil, free from any soluble salts, was about 7.5 as against 8.5 to 9.2 found on spots affected by *kalar* or salts in varying degree. Failure of crops on such soils as show a pH value of 9.2 and above may be ascribed to the greater alkaline reaction of the soil but a similar failure of crops on land having a pH value of 7.2 and containing very little or inappreciable quantity of soluble salts indicated that the cause of barrenness may lie in bad physical texture of the soil and want of plant food or bad cultural treatment. In the acid soils of **DACCA** and **JORHAT** lined plots in all years have given a higher yield. Rain and the presence of water in the field have a decided action in altering the pH value and bringing it more or less towards neutrality, specially in the water over the plots. The mud shaken up with supernatant water has often given a higher pH than that of supernatant water. The analysis of supernatant water so far has revealed little ; but it has given a large percentage of soluble manganese as compared

to that of Rajshahi where the amount was a mere trace. To the alkaline soil of Rajshahi sulphur was added for two years but the buffer action of the soil was too strong to permit any marked change. Whereas in acid soils of TOCKLAI comparatively small additions of sulphur effected considerable change in the acidity. At Kanke, Ballia and Cuttack in BIHAR AND ORISSA permanent manurial plots were laid down to study the pH values and the nature of the exchange bases. At PUSA in two acid soils from Neterhat, Chota Nagpur, the maximum nitrification and growth of linseed plants were obtained only when twice the lime requirement of the soil, calculated by the Hutchinson and MacLennan method, was added. This year in Dacca unmanured soil, pH 5.9 and with a calculated lime requirement of 0.152 per cent., one-and-a-half times the amount of the lime requirement had to be added to produce the maximum crop of linseed. Maximum nitrification of sulphate of ammonia was found when three times the calculated lime requirement was added. In the Neterhat soil the beneficial effect of the previous year's addition of lime was still prominent. At TOCKLAI a thorough study was made of the electrometric determination of soil acidity by (1) the quinhydrone method using Veibel's standard quinhydrone half-cell, (2) the quinhydrone method using a standard calomel half-cell, and (3) the antimony electrode using any standard half cell. It appears that test solutions should be stirred while taking readings in order to get the correct pH. In the case of soils the decrease in pH resulting from stirring the solutions is often very marked. With the antimony electrode, readings even with buffer solutions were liable to fluctuations whether the solutions were stirred or not, while with soils the fluctuations were more prominent. This method was discontinued until further details on the construction of the electrode are available. It is thought that impurities in the antimony and incorrect methods for casting and polishing the electrode are responsible for the fluctuation in E. M. F. In the case of soils there is generally very little change in E. M. F. with temperature changes between 15° C. and 40° C., with few exceptions. The pH of the soil decreases by at

least 0.1 for a 10° rise in temperature. This decrease in pH has been commented on by other workers in connection with many extracts as sewage sludge and nickel-plating solutions. After a study of the variation of pH with soil-water concentration, it was decided to adopt a 7 : 5 ratio of soil to water. A large number of tea soils were tested electrometrically and compared with the colorimetric results. In the case of soil in which the colorimetric pH of the potassium nitrate extract is as high as, or higher than, that of the 1 : 3 soil-water suspension, there is no agreement between electrometric and colorimetric pH values, the former being always higher than the latter. In the case of more normal tea soils, showing a direct pH round about 5.0-6.0 and a potassium nitrate extract pH about 4.0-5.0, closer agreement between colorimetric and electrometric pH's is obtained. The effect of adding lime to an acid soil was studied both in the laboratory and in the field, and results showed that when lime is added to an acid soil, the reduction in acidity, which is great at first, becomes less and less as neutrality is approached. Half of each plot of the Tocklai lime plots was treated with sulphur in quantity sufficient to neutralise the original lime added. This theoretically should bring the soil acidity back to its original value. In every case the sulphur addition has increased the acidity to a greater extent than equivalent quantities of lime decreased it and now the acidity on the sulphured plots is well above the original figure for the untreated soil. Soils that have too low an acidity to grow tea well may be made more acid by the addition of sulphur which combines with the basic substances like lime and magnesia to form sulphate of lime and sulphate of magnesia. Owing to the high cost of sulphur, its use is practicable only on soils which are not too alkaline, and where the area to be treated is not too large. The effect of addition of sulphur to different types of soil is being studied in the laboratory and in the field. So far comparatively small additions of sulphur on the field have effected a big change in acidity, while larger doses have reduced the acidity below that tolerated by tea since on the heavily-treated plots the tea is rapidly dying out. Another important point is that even a year after completion of the sulphur

applications, there is still further reduction in acidity on both the sulphur-treated plots and those treated with sulphate of ammonia. Before making recommendations for correcting low acidity by additions of sulphur, it is necessary at present to make laboratory tests since different soils react differently to any given amount of sulphur. Sulphate of ammonia has given a marked increase in soil acidity at Borbhetta and, if its use were persisted in for any length of time on soils of the type of Borbhetta, a pronounced acid condition would result. It is, however, to be noted that as the quantity of potash and phosphate used with sulphate of ammonia increases, so there is a less tendency for the soil to change its acidity. For soils having a rather low acidity the use of ammonium sulphate provides a satisfactory method by which to increase the acidity and at the same time provide a readily available supply of nitrogen.

At PUSA it was found that the same soil shows different lime-requirements according to the method of determination employed. Further experiments were made with ten well-known lime-requirement methods on five soils, to ascertain whether the experimental determination of residual lime-requirement after a known quantity of lime was added to the soil, agreed with the calculated one. No such agreement was found, thus emphasising the fact that a lime-requirement method serves only as a qualitative guide to the soil investigator.

Soil Colloids. From experiments carried out at PUSA the Physical Chemist formulated the theory that the soil particle could be considered as a colloidal tribasic acid with three replaceable surface-active hydrogen atoms, and that the degree of dispersion and the flocculation capacity of soils depend on the nature and degree of saturation of the exchangeable ions. Bacterial activity and plant growth were conditioned by the degree of saturation of the soil colloid. Nitrification and nitrogen fixation were checked when the soil colloid was unsaturated and normal growth took place when the first hydrogen ion was neutralized. Sodium ions were not directly toxic to plants but affected adversely the physical texture of the soil. At the CALCUTTA UNIVERSITY the titra-

tion curves of sparingly soluble acids are being studied in relation to the behaviour of clay soils, and systematic colloid chemical analyses of aluminium hydroxide sol and silica sol, including the determination of the concentration of the different ions, composition of the colloid micelle and intermicellary fluid, are in progress. In BURMA an important investigation into the question why certain soils are liable to be washed away and therefore are of little value for making irrigation bunds showed that the cause of the trouble was the presence of large amounts of replaceable sodium in the clay complex of the soil. A simple test was devised whereby soils are shaken with water in the proportion of 1 to 10 for an hour after which samples are poured into test-tubes and allowed to stand. Such soils give permanent suspensions while good soils settle rapidly.

Reclamation of alkali soils. Pusa soils from a spot where sugarcane was growing very badly and from one where it grew luxuriantly, as well as alkali soils from Sakrand in Sind, were examined for their total water-soluble salts, the cations Ca^{++} , Mg^{++} , K^+ , Na^+ and the anions SO_4^{--} , Cl^- , CO_3^{--} . With regard to the Pusa soil, it was found that the total salts, which exceeded 2 per cent. by weight in the top 3 inches of the bad soil, were 10 to 12 times more than those in the adjoining good soil. Sodium sulphate was the predominant constituent in the soluble salts and the amount of sodium carbonate was very small, although the soils were highly calcareous. The failure of crops in these alkali patches may be due either to the retardation of nitrification through high salt-content, or to plasmolysis of the cell saps of the young plant by the high concentration of the salt. With regard to the alkali soils of Sakrand (Sind) from the *kalar* area, the soil reaction of the whole profile shows that the medium is alkaline and that the distribution of the ions throughout would be such as to favour the formation of a solonetz soil in time. The process of solonization is characterized by two distinct phases : (1) In an alkaline medium accumulation of the salts of alkali metals takes place in the surface horizon ; (2) the second is a base-exchange process, in which calcium from the zeolite humus complex is replaced by sodium, giving rise to a sodium complex with the characteristic structure of a solonetz

soil. Exchanged cations go into solution and are washed down into deeper horizons. This results in the accumulation of gypsum in the sub-soil in the form of a hard pan. From the data obtained so far on the water-extracts of Sakrand soil, this striking tendency of the monovalent ions to rise to the surface and the bivalent ions to leach downwards has been clearly exhibited. Existence of a hard gypsum layer has also been noted at a depth of $18\frac{1}{2}$ " to $24\frac{1}{2}$ ".

The *kalar* lands of SIND contain from 0.5 to 11 per cent. of soluble salts, the injurious salts commonly present being sodium chloride and sodium sulphate. In some cases magnesium chloride is also found in appreciable quantities. The nitrogen-fixing power is much less than in the salt-free soils. The reclamation experiments tried by leaching with different quantities of water and the application of chemicals like calcium chloride gave encouraging results. Frequent cropping with berseem appears to renovate such soils remarkably. At Partabgarh in the UNITED PROVINCES four methods of reclamation were in progress, viz., deep ploughing in the rains with improved drainage, growing deep-rooted salt-loving leguminous crops, holding flood-water by means of bunds and mixing gravel with the soil. Similar experiments were also carried out in BIHAR and also in TRAVANCORE where the alkaline soils of the south contain a high percentage of sodium carbonate and a fair amount of calcium carbonate. Experiments at Nagercoil indicated that treatment with sulphur followed by the application of farmyard manure rendered these soils fit for rice cultivation. In the PUNJAB experiments started in 1927 to try the effect of calcium chloride and gypsum on three types of *kalar* land showed that after four years some of the treated plots gave almost the same yield of wheat as normal soil in the locality.

2. Soil fertility.

Under perennial irrigation from the Lloyd Barrage and with a much more intensive system of agriculture, the maintenance of soil fertility in the Barrage areas is a subject of the greatest importance. Hitherto, the fertility of cultivated lands has been kept up by a system of fallows which must be considerably reduced

under post-barrage conditions of irrigation and agriculture. The main lines along which this problem is being investigated by the Agricultural Department in SIND are the adoption of crop-rotations in which restorative crops occupy a large proportion, *i.e.*, fertility rotations, by conserving crop residues and waste organic matter and converting them into useful composts and by the use of green manure crops and artificial manures. A fertility rotation, "Sakrand D", is under test at the Agricultural Research Station, Sakrand, in which 19 per cent. of the area is cropped annually with leguminous crops like groundnut, *guar*, pulses and berseem. This rotation has the advantage of being easily adapted to mixed farming where the possibilities of such a system of agriculture exist. At the same time, it is equally suited for a system based on crop production only. The data are being carefully maintained but will only be comparable when the cycle of rotation is completed, *i.e.*, after five years. At TOCKLAI, ammonium sulphate gave quick and marked increases in yield in tea directly proportional to the quantities up to the very high limit of 120 lbs. nitrogen per acre, and the use of any quantity of potash or phosphoric, or of any combination of the two together with the sulphate of ammonia, made no difference in yield whether the nitrogen was applied in one dose or in successive small doses. Plots to which nitrate of soda was applied in a number of small doses were no better than those to which the same quantities were applied in one dose. Continued use of nitrate of soda interfered adversely with the tilth of the soil and the plots looked bad because of the yellowing and blackening of the leaf, but the application of ammonium sulphate at this stage was attended with immediate good effect.

At PUSA, in the two series of rotation experiments started in 1929-30 to test the influence of leguminous crops on the conservation of soil nitrogen, three crops have been taken. The figures for total nitrogen remaining in the soil at the end of two years were less than at the beginning of the experiment. This decrease may partly be due to seasonal fluctuations as was observed in many other plots. Taking into account the nitrogen removed by the crops, however, a gain in nitrogen is noticed in all the plots.

The highest gain calculated in this way is 210.5 lbs. per acre in one series with a mixed crop of maize and *urid* (*Phaseolus radiatus*) grown in the *kharif* summer season and 177 lbs. per acre in the second series with *kerao* (*Pisum arvense*) grown alone in the *rabi* winter season. The mixed crops have given the highest economic returns, whether grown in the *kharif* or *rabi* season.

3. Nitrification.

At Pusa, when calcium cyanamide was treated with dilute sulphuric acid for two or three weeks and then added to Pusa soil, two-thirds of the added nitrogen was recovered as nitrate. No nitrate was recovered when untreated cyanamide was added. Urea was formed by the acid treatment. Treatment with alkali also results in urea formation, but only one-fifth of the nitrogen of alkali-treated cyanamide was recovered as nitrate from Pusa soil. As the nitrification of calcium cyanamide is often long delayed or non-existent when quantities large enough to add 30 mgs. of nitrogen to 100 grms. soil are taken, the changes taking place in the early stages were studied in seventeen soils from different parts of India. The results showed that in soils of pH 7.0 or more, no urea was produced and in these soils cyanamide persisted and even after many weeks incubation did not nitrify. In the soils of pH 5.0 to 6.9 there was production of urea, disappearance of the cyanamide form of nitrogen, and, except in one soil from Dacca, nitrification began after incubation for a varying number of weeks. A study of the effect of single alkali salts on nitrification showed that the concentrations necessary to inhibit nitrification were much higher than those recorded for American soils. In soil from Kalol the addition of 0.75 per cent. of sodium carbonate delayed the nitrification of ammonium sulphate and suppressed that of mustard cake. In Chinsurah soil one per cent. sodium carbonate failed to prevent the nitrification of mustard cake. The maximum amount of nitrate found was 24 mgs. per 100 grms. soil in which 0.2 per cent. sodium carbonate was added; when one per cent. was added, the amount of nitrate found fell to 12.9 mgs. In Jorhat soils nitrification of both mustard cake and ammonium sulphate

was stimulated by additions of sodium carbonate up to 0.2 per cent. but adversely affected by higher concentrations. Nitrification in these soils was depressed by 0.2 per cent. sodium sulphate. In Pusa soil 0.2 per cent. sodium sulphate had no influence on nitrification while 0.5 per cent. checked nitrification for four weeks, after which time it proceeded normally ; and 0.1 per cent. of sodium chloride did not affect the nitrification of ammonium sulphate, but retarded that of mustard cake. Increasing doses of sodium chloride hindered nitrification, till one per cent. checked it for ten weeks, after which it proceeded slowly. With a view to see how far these results apply to alkali soils containing mixtures of these salts, two samples of *bara* soil from the Punjab and a *reh* soil collected locally were studied. It was found that in one *bara* soil the whole of nitrogen as ammonium sulphate and 80 per cent. of the organic nitrogen in cake was nitrified in eight weeks, while in the other nearly 60 per cent. of the nitrogen in cake was nitrified. In *reh* soil nitrification of ammonium sulphate was not affected by the salts, 80 to 90 per cent. of nitrogen being nitrified in eight weeks, but in the case of oil-cake, only 30-40 per cent. nitrogen was nitrified. The concentration of sodium sulphate in the *reh* soils was 0.449 per cent. in the first three inches and 0.271 per cent. in the first six inches, while sodium chloride was present to the extent of 0.047 and 0.035 per cent., respectively. In *bara* soil sodium sulphate was less than 0.034 per cent. and sodium chloride less than 0.041 per cent., but 0.03 to 0.06 per cent. sodium bicarbonate was present in these soils. In the local *reh* soils sodium bicarbonate was not noticeably present. Experiments on nitrification of crushed *til* (*Sesamum indicum*) seed, extracted of its oil to different extents, were carried out in Pusa and Kalianpur soils. In Pusa soils the nitrate accumulation was lowered by the presence of the oil to a slight extent, being only 10 per cent. less than the control. All samples containing oil from 4 to 15 per cent. gave the same decrease in nitrates. In the Kalianpur soil the amount of nitrogen nitrified in the presence of 4 per cent. oil was 15 per cent. lower than in the control ; but with higher quantities, viz., 12 per cent. and 15 per cent. of oil, the amount was lowered by 32 per cent.

This difference in the effect of the oil in the two soils is attributed to the difference in the lime content, 30 to 40 per cent. in Pusa soil and less than 2 per cent. in the Kalianpur soil.

At TOCKLAI, in continuation of work done in past years in connection with nitrates and ammonia in the soil, a further series of plots were examined weekly. January and February were dry but during March when good rain is normally expected only a few showers fell which were insufficient to penetrate into the soil. From April 18th heavy and continuous rain fell till the end of the month. The highest figure recorded for nitrates in the unmanured plots was 4 parts per million as against an average of 15 parts per million throughout April 1930. The figures for the manured plots were correspondingly low. It is to be noted that in spite of the low nitrates, recorded crops for this season were better than in 1930. Manures were applied on the 16th April; 6 days later on the morning of the 22nd, nitrates had reached a high figure of 26.5 parts per million. Two-and-a-half inches of rain fell that night and another 4.2 inches before the morning of the 29th. When the next sample was taken it showed only a moderate nitrate content of 5.2 parts per million. From this time onwards the nitrate of soda plots were no richer in nitrate than the unmanured plot. The total crop for the season from the nitrate of soda plot was approximately 23 per cent. higher than from the unmanured plot. In October a significantly larger crop was obtained from the nitrate of soda plot. This seems to indicate that an increased food-supply persisting in the soil for a very short period can produce increased crop long afterwards. Heavy rain falling just after the application of the manures may have caused soluble forms of nitrogen in the sub-soil to play a more important part than usual. Both nitrates and ammonia were relatively high at least down to 3 feet on the manured plots (sulphate of ammonia) which were regularly sampled below the surface. To determine whether there was any concentration of nitrates at lower depths on the nitrate of soda plots which had shown such a rapid disappearance of nitrate from the surface soil between the 22nd April and 6th May, these plots were sampled down to 3 feet

from the 30th May onwards. Between the 13th May and 11th June, there is a considerable concentration of nitrate at 3 feet deep, compared either to the unmanured or to the sulphate of ammonia plots. There is not during the season any indication of nitrate returning from the deeper subsoil to the surface, except possibly during the period May 27th to June 4th, but this was the only period of time when the soil was dry, otherwise rain fell continuously up to August 13th so that percolation downwards must have been continuous. The natural nitrifying power of a soil from one of the cultivation plots has been determined weekly, to find whether the rate of increase of nitrate under standard conditions may be taken as a constant for a given soil in an air-dry condition. The results are satisfactory, but when the initial nitrate of the soil is high (as in April) a complication occurs. Thus, while the initial nitrate of the soil in question lay between 2 and 20 parts per million, the soil was capable of increasing its nitrate by roughly 10 parts per million in two weeks. The natural nitrifying power of this soil is therefore taken as 10, which appears to be a reasonable figure for a soil of moderate fertility. When, however, the initial nitrate had risen to the region of 30 parts per million further nitrate production did not occur, and in some cases a loss resulted on incubation. It therefore appears that there is a definite maximum nitrate figure for soils not under the action of fertilizers, and analyses of Red Bank soils have shown that this figure varies with different soils. A special interpretation of natural nitrification figures may be necessary when the initial nitrate is high, and in general it would be preferable to determine the nitrifying power of a soil on a sample taken during the rains. In a carefully designed experiment in COIMBATORE, green manure, cattle manure and ammonium sulphate were applied at such a rate that the nitrogen-content of the soil was increased by 30 parts per million of dry soil and cotton was grown. The results of analyses of fortnightly samples showed the presence of nitrates to a depth of 3 feet, and that active nitrification was occurring only in the first foot layer of the soil. A decrease of nitrate in the surface foot of the soil is not accompanied

by an increase in the second and third foot layers of the soil, and this indicates that no downward movement of nitrates was taking place. Although the concentration of nitrogen in the cotton plant is greatest in the early stages of the plant, the crop made large demands on soil nitrogen from about the end of October to the end of December—a period of rapid vegetative growth. The absorption of nitrogen was more steady in the plots receiving organic manure than in the plot receiving ammonium sulphate where the curves for nitrate nitrogen show more violent fluctuations. The disappearance of nitrate nitrogen either in the cropped or uncropped plots may be explained on the score that it was being utilized by the crop or was being converted into insoluble forms of nitrogen and held in the soil. But an examination of the figures for total nitrogen shows that nitrogen is being actually lost in varying amounts from the different plots. The presence or otherwise of organic matter and the dynamic equilibrium ratio of carbon to nitrogen appeared to determine the loss or otherwise of nitrogen.

At PUSA the organic nitrogen and nitrate nitrogen at different depths were determined on manured plots, and large increases of nitrate were found where green manure had been applied and especially where it was used in combination with superphosphate.

4. Manures and Fertilizers.

Manures. In connection with all kinds of field experiments, improved methods of lay-out, involving the technique of randomization and replication of plots and statistical study, have in recent years enabled the experimenter to take account of the effects due to soil variation and to estimate the degree of reliability based upon errors due to chance, so that it has now become possible to deduce satisfactorily the full implication of differences between different treatments. This has led to a more correct interpretation of results in all field-experiments on varietal, cultural and yield tests and nowhere has this been shown to better advantage than in manurial experiments. Mention has already been made in Chapter 1 of the work of the Fertilizers Committee of the Imperial Council of Agricultural Research. The most necessary factor to maintain

and improve soil fertility is the existence of sufficient humus in the soil for which a steady supply of organic matter is imperative. The results of the permanent manurial plots at COIMBATORE conducted for over twenty years, though unreplicated, show that farmyard manure possesses advantages in the matter of yield as well as quality of the crop obtained, over mineral manures. As regards yield, it is stated that though artificial fertilizers show superiority over farmyard manure in some cases in the earlier years of their application, in later years, farmyard manure asserts itself in contributing to greater yields and that mineral manures are capable of being better utilized in the presence of sufficient supplies of organic matter than when applied alone. These results are corroborated by the permanent manurial plots on wheat and maize in the CAWNPORE FARM manured from 1883 to 1913 and unmanured since then, where the direct and residual effects of cowdung, sheepdung and poudrette have been found definitely superior to saltpetre or saltpetre plus bone-superphosphate. As regards quality of the crop, results in Coimbatore show that the seed obtained on the cattle-manured plots possesses higher nutritive value than that raised with mineral manures. Apart, therefore, from the indirect benefits conferred by organic manures on plant growth in improving the texture and water-holding capacity of the soil and in providing food for soil bacteria, organic matter appears to give the plant a better balanced nutrition. A series of experiments at PUSA indicated that the addition of 1 to 2 per cent. of superphosphate to cow or bullock dung greatly diminishes the loss of nitrogen during ten months' storage and a much higher percentage of nitrogen becomes recoverable as ammonia from the dung plus super mixture than from dung alone. There is, however, little hope of large quantities of cattle manure becoming available until an alternative source of fuel comes into general use and some form of mixed farming is generally adopted. The most promising alternative sources of organic matter for the soil are composts, green manures and oil-cakes.

COMPOSTS. The composting of waste materials like sugarcane and plantain trash, prickly-pear, groundnut husk, leaves of coconut

palms and other trees, stalks of gingelly,[†] cotton and pigeon pea, water-hyacinth weeds, village sweepings and other vegetable useless matter has been carried on by most departments of agriculture, and much progress has been made in inducing cultivators to take up the practice. This artificial farmyard manure has given in many places as good yields as the natural stuff. A review of the recent experiments on its preparation was published in Vol. XXV of the *Agricultural Journal of India*.

GREEN MANURE. The benefits of green manure too are well established and experiments are now carried on with a view to find the best plant for particular localities. In PUSA sann-hemp and a relative *Crotalaria servicea*, Mexican sunflower, soy bean and *urid* did well, with and without superphosphate, for sugarcane, wheat, potatoes and onions. In MADRAS the use of green manure in conjunction with superphosphate and bonemeal for rice is extending rapidly and is found to be very efficient, better than all manures excepting oil-cakes and superphosphate alone. The usual plants used are *dhaincha*, sann-hemp, indigo and *Phaseolus trilobus* and the extra yield is from 15 to 20 per cent. At the Kumpta farm in BOMBAY, *Nux vomica* and *Terminalia paniculata*, in combination with bonemeal, have increased the yield of rice in the husk by 149 and 94 per cent., respectively, over the check farmyard manure plots and this has happened for three years. At Shahjahanpur in the UNITED PROVINCES the green-manured plots gave an extra yield of 250 maunds per acre of Co. 213 and 275 maunds of Co. 243, which at current prices came to Rs. 94 and Rs. 104, respectively. In the CENTRAL PROVINCES sann-hemp with superphosphate and in BIHAR AND ORISSA *dhaincha* with superphosphate are considered the best manures for rice. At Mudon in BURMA *Centrosema pubescens*, *Colopogonium mucunoides*, *Candida* and *Crotalaria anagyroides* were found to suit the local conditions.

OIL-CAKES are used on profitable crops like sugarcane where other forms of organic matter are in defect. In PUSA in an experiment with oil-cake and sodium nitrate and combinations of both, the highest returns were got with 15 to 20 maunds of oil-cake per acre ; sodium nitrate in addition to, or in part replacement of, oil-

cake, had no advantage. In experiments at SAMALKOTA the average of the last four years showed that on first-crop rice an increased yield over no manure of 7·4 per cent. was secured with castor-cake alone and of 16 per cent. with castor-cake and superphosphate, while on second-crop rice increased yields of 13 and 85 per cent., respectively, were secured.

BONE MANURE. At the instance of the Fertilizers Committee, several provinces have undertaken an investigation regarding the disintegration of bones. The results of the work at PUSA on treatment with superheated steam with easily available chemicals and by fermentation in composts were published in March 1931, in *Agriculture and Livestock in India*. At Poona, by means of a grant from the Sir Sassoon David Trust Fund, the Agricultural Chemist has tried a number of treatments and analysed the nitrogen and phosphoric acid available. Bonemeal is having an increasing use for rice fields in Madras, on the acid soils of Kumpta in Bombay, in Bihar and Orissa, in the Central Provinces and in Burma.

Fertilizers. Experiments conducted at Coimbatore showed that sodium nitrate increased rice yields by from 15 to 20 per cent. but in comparative trials it was inferior to green manure, while laboratory investigation on the nature of its action showed that it was more physical than biological. At Lyallpur it was found to be of distinct value for wheat after wheat, 123·4 lbs. of the manure giving during three years 21·3, 21·5 and 43·5 per cent. increases over no manure.

Calcium cyanamide did rather better than ammophos at Pusa on maize followed by oats; and on the acid soils of Kumpta in Bombay it gave a very good response. In the light loam of the Lyallpur farm, where the soil fertility was poor, it gave high yields, 123·4 lbs. of the manure giving during three years increases of 90, 60 and 41 per cent., respectively, over no manure.

Ammonium sulphate in combination with superphosphate did well on rice in Samalkota and, in combination with groundnut-cake, on sugarcane. Alone it was found to be a suitable manure for rice on the trap soils of Karjat in Bombay where it gave from 40 to 50 per cent. of increased yield over no manure. Experiments on

cotton at Lyallpur carried on for four years provided fairly strong evidence that a top dressing of ammonium sulphate about the end of August increases the yield and these results agree with those of experiments at Surat. Ammonium phosphate of various types was of value as a top dressing on most crops in Bengal.

The use of phosphatic manures alone or mixed with other artificials and organic manures, or supplemented by green manure, is now becoming popular in several provinces. Superphosphate is found to be of particular advantage to rice, cane, tea and rubber and is being largely used in the Madras Presidency. In Coimbatore Central Farm, the soil of which is not deficient in any of the elements, superphosphate mixed with cyanamide showed an increase on rice of 23 per cent. over control, while in Hagari, with its black soil poor in nitrogen and phosphoric acid, ammonium sulphate (164 lbs. plus superphosphate 82 lbs.) increased the yields of sorghum by 146 per cent. and those of cotton residually by 90 per cent. But the soils and crops in India seem to require a judicious combination of nitrogenous and phosphatic manures, and this explains the increasing popularity of compound manures like ammophos, diammonphos and leunaphos. In North Bihar ammophos (14-20) at 3 maunds per acre has proved useful for sugarcane, while in south Bihar niciphos is better. In Burma the residual effect of fertilizers on rice is shown to be significant in the case of diammonphos, superphosphate and lime. An experiment to determine the optimum dressing of leunaphos shows that the best return, from the small cultivator's point of view, is obtained from a dressing of 50 lbs. per acre with an increase in grain of 38 per cent. The maximum profit, on the other hand, was obtained from a dressing of 200 lbs. which gave an increase in grain of 92.5 per cent. When the fertilizer was applied to land covered with water 4 to 6 inches deep, there was a much smaller increase of grain. For the best results, the fertilizer must be applied immediately before transplanting and be thoroughly worked into the soil. The interesting experiment was made of top dressing paddy, badly attacked with *Sclerotium oryzae*, with leunaphos at 100 lbs. per acre. Within a week there was a striking difference between the treated and

untreated plots. Within a month the former had grown much in advance of the latter and showed no external signs of disease. At harvest the treated plot showed a net increase of 80 per cent. of grain and an increased profit of Rs. 19 per acre. Top dressing evidently has great possibilities. Further work has shown that the 20-50 grade diammonphos is likely to exert a better residual effect after the first year than the 20-20 grade, but that the latter is to be recommended in most areas for giving a quick return in the first year. Applications of fertilizers of the ammonium phosphate type are not yet to be recommended for regions of high rainfall like Arakan and Tenasserim where, it appears, the fertilizer is partly lost by flooding and erosion. The officers of the department during the last ten years have conducted careful and elaborate experiments on all the central farms and especially on those dealing with paddy, to determine the best fertilizers, the correct amounts to apply, the best methods of application, and the frequency with which they should be applied. The results at Hmawbi, Mandalay and other stations were most promising and when the price of rice was standing at Rs. 160, substantial benefits were obtained from the use of these materials and several agencies for their sale were opened in Rangoon. In Mysore, too, practically all the crops experimented with, *viz.*, coffee, cotton, sugarcane, coconut, arecanut, rice, *ragi*, *jowar* and cotton, responded to the use of nitrogenous and phosphatic manures and the most striking results were obtained from the readily available forms of artificial fertilizers. The fall in the price of these crops, however, by nearly 50 per cent. in one year has put a different aspect on the matter, for the fall in the price of fertilizers has been not more than 10 per cent. in the same time. Unless conditions improve, commercial fertilizers cannot be used profitably except on a comparatively small number of crops like sugarcane and coffee with rice on the border line. All that the departments can do, therefore, in the meantime is to continue their experiments and collect as much data as possible.

5. Water requirements of crops.

At ANAKAPALLE RESEARCH STATION experiments have been in progress for the past four years to find out the minimum amount

of water that is necessary to raise sugarcane. The quantity of water used by the ryots is much in excess of requirements and this restricts the time at which the crop is cultivated only to periods when water is available in abundance. Experiments at the station have conclusively proved that with Co. 213 cane, provided the land received a deep cultivation and hoeing to start with, the number of irrigations could be reduced to one, with better yields of jaggery, the number of irrigations usually given by the ryots being 5 to 10. At the SAKRAND RESEARCH STATION in Sind, two varieties of wheat, Pusa 12 and C. Ph. 47, were tried with different quantities of water and the yields indicated that C. Ph. 47 gave as much yield with 12·8 acre inches of water as Pusa 12 would give with 16·5 acre inches of water. Given the same quantity of water, the Sind wheat was capable of giving a higher yield than the Pusa variety.

Important experiments on the duty of water for paddy under tank irrigation have been in progress in MYSORE for five years and were brought to a close in 1929-30. Six separate crops were tried and the results showed that though the rather wasteful application of water which is now taking place gives a somewhat higher yield, a very much more economic utilization of water is possible. For instance, with reference to paddy, it has been shown that by doubling the supply of water, only about 9 per cent. increase in yield was obtained, showing that same amount of water could be utilized for irrigating twice the area with profit.

6. Agricultural meteorology.

The general relationship between weather and agriculture is probably more widely recognised in India than elsewhere. Apart, however, from the recognition of the general relationship, there is very little exact knowledge about the true relationships, *e.g.*, about the amounts of rainfall that are effective and about the times when rainfall, sunshine, temperature and humidity are beneficial or harmful. It is also obvious that if satisfactory correlation between weather conditions and crop yield and crop areas can be established, crop forecasting will be improved. The Imperial Council of Agri-

cultural Research sanctioned a grant to establish a Branch of Agricultural Meteorology to be temporarily attached to the headquarters of the Meteorological Department at Poona. Besides the statistical and routine side, work has begun on the research side where the proposal is that the investigations should first aim at selecting (in consultation with agricultural workers) the best methods and standardising them for the measurement of radiation, evaporation, soil temperature and soil humidity, so that these data may ultimately be systematically maintained, in addition to those of air temperature and air humidity, rainfall, wind, sunshine, etc. The other research problems will mainly be concerned with the question of "effective" rainfall, the meteorology of the air layers near the ground and the flow of heat and water through the ground surface (a branch of work which will come in contact with the physical chemist's); there will also arise opportunities for joint work with biologists and mycologists, *e.g.*, on the effect of varying meteorological factors on plants, fungi, insect pests, etc. By investigating methods and devising instruments, the agricultural meteorologists will be able to render considerable assistance to work already in progress at certain experimental stations such as the Sakrand Agricultural Experiment Station in Sind, the Cotton Research Institute at Lyallpur, and the Pusa Research Institute.

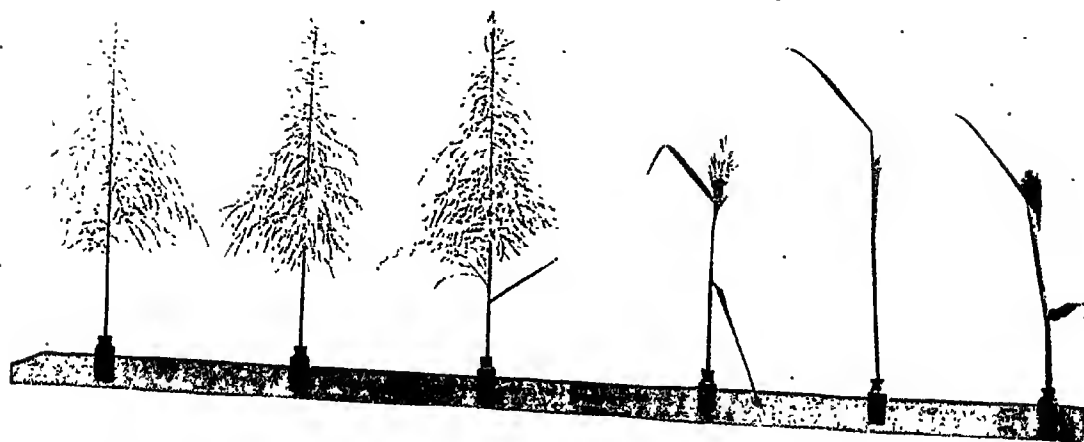
7. Plant-breeding and genetics.

In these days of advanced methods of agriculture when only the best and most productive strains of crops interest producer and consumer alike, plant-breeding is of primary importance. Results in this work have achieved surprising success and the productivity on a given acreage both as regards amount and quality would amaze cultivators of a by-gone and less enlightened age. Every province has its plant-breeder and some have several, all engaged in breeding strains for particular purposes of the staple crop plants of the province. Plant-breeding work has, as a rule, three stages, the isolation of the different strains which go to make up the local mixture, the identification of the different characters found present and a study of their inheritance, and lastly, the crossing of one strain

with another with the object of obtaining strains of higher economic value. Besides evolving good quality high-yielding strains, the plant-breeder has of recent years concerned himself with evolving strains having disease resistance. Diseases on most crops in India are so diverse and frequent and their cause so difficult to understand by the growers who have come to look on them as visitations of Providence, that this line of work of the plant-breeder enables the grower to secure the benefit of better varieties in all years. Frequent reference to individual cases has been made in Chapter I, where under the various crop headings a good deal has been said about the economic successes, but a few more activities remain to be mentioned. The classification of local rices and the inheritance of characters of rice has been studied in Pusa, Madras, Bombay, Bengal, the United Provinces, Assam and Mysore. The characters of the cotton both in relation to its flowering period and position on the plant, the inheritance of floral colour and the variation of lint length were studied in Madras and Bombay, and general breeding in the Punjab, the Central Provinces and Mysore. Wheat-breeding has gone on in Pusa, Bombay and the provinces of Northern India. At Pusa a classification of types of barley was made preparatory to breeding operations and hybridization of oats was studied. At Coimbatore, work was done on *jowar*, *bajra* and *ragi* and at Pusa on the varieties of gram. From Pusa came a paper on the improvement of Indian cigarette tobacco by hybridization and one on the study of sex in hemp. At this station the plant-breeding of linseed, hemp, chillies, and *Hibiscus* was in progress. Both in the Central Provinces and in Pusa was a study of pigeon-pea carried to a definite conclusion. A start was made in coffee-breeding in Mysore and the first authentic cross between *arabica* and *robusta* was planted out. Both in Mysore and Coimbatore breeding of varieties of sugarcane was in progress, also in the latter place the pollen-grain and ovary of sugarcane before and after fertilization were studied. In Coimbatore too the most interesting and valuable cross between sugarcane and *jowar* was made in 1929. The cane parent was P. O. J. 2725 and the *jowar* parent the variety known as Periamanjil (Plate I). Useful combinations are rarer even among these hybrids

INFLORESCENCES OF SUGARCANE \times SORGHUM HYBRIDS.

PLATE I.

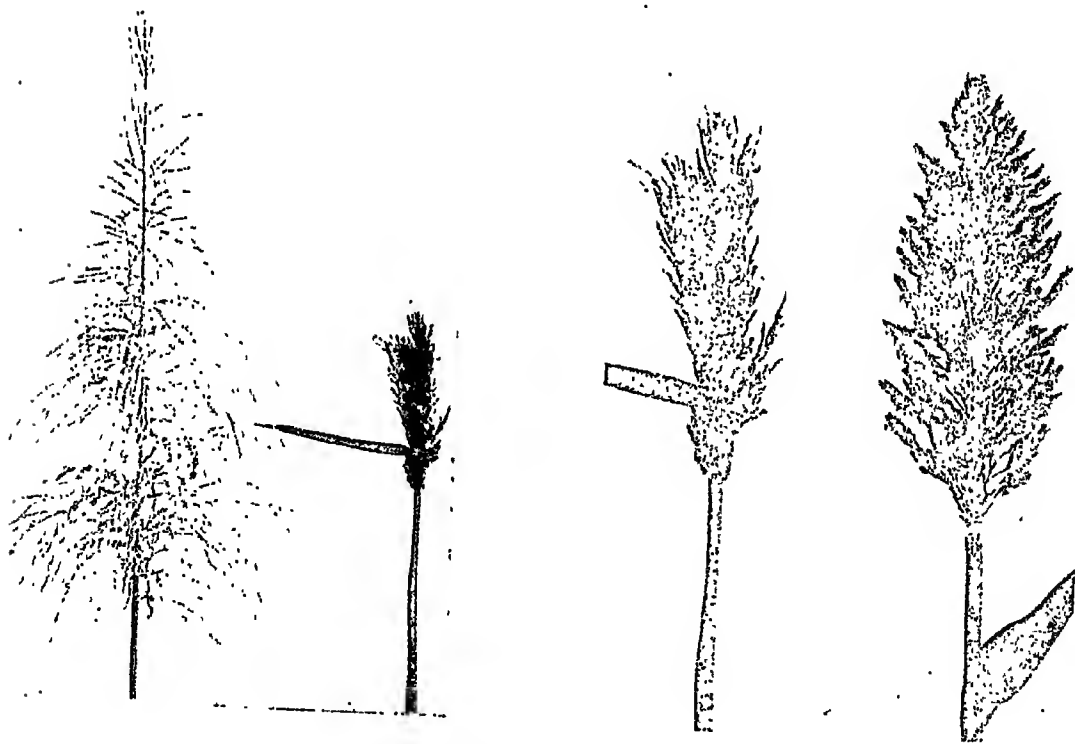


P.O.J.2725.

P.O.J.2725 \times Sugarcane.

P.O.J.2725 \times Sorghum.

Sorghum.



P.O.J.2725.

P.O.J.2725 \times Sorghum Hybrid No. 50.

Sorghum.

Reproduced from the Scientific Reports of the Imperial Institute of Agricultural Research, Pusa, 1930-31.

than they are among cane seedlings where they are by no means common. The more vigorous of the hybrids which matured in 6 months were analysed in the second year and the juice analysis is given in the following table :—

Juice analyses of sugarcane-sorghum hybrids, six months old.

Seedling No.	Brix per cent.	Sucrose per cent.	Glucose per cent.	Co-efficient of purity.
Co. 351	20.42	18.53	0.17	90.8
Co. 352	19.31	17.33	0.26	89.6
Co. 353	19.01	16.75	0.42	88.1
Co. 354	18.38	16.18	0.41	88.0
Co. 355	17.71	15.22	0.58	85.9
Co. 356	18.51	16.11	0.50	87.0
Co. 357	20.15	18.00	0.18	89.3

Already the progeny of this cane-*jowar* cross has shown that early-maturing canes with a high sucrose-content will be available which may enable the sugar mills to begin operations each season a month earlier than they can do at present and that more nutritious and palatable fodder *jowars* may be evolved.

8. Plant physiology.

At Surat a scheme financed by the Indian Central Cotton Committee set out to discover the causes of the large amount of shedding of buds, flowers and bolls in the cotton plant and a very considerable amount of knowledge about the physiology of the cotton plant has been recorded though no method has been discovered by which the shedding would be reduced. In the Punjab the investigation of the periodic failure of Punjab-American cotton has been going on for some years. The Cotton Research Botanist has written two papers on the physiological response of the cotton plant to its environment.

He says that the experimental evidence shows that, during the development of the cotton plant in the Punjab, the surrounding climatic factors may produce unfavourable reactions in the plant. In some years the effect of certain conditions, or the accumulated effect of a succession of unfavourable conditions, is sufficiently severe to produce a general pathological state in the plant, which shows

itself eventually in the failure of the bolls to open properly. The cause of this lies in the depressant effect these factors have on root development, particularly in the early stages. Where root-growth is satisfactory, a good crop can be matured, and where root-growth is restricted, the bolls open badly. Convincing examples of this were found in the 1928 and 1929 root-restriction experiments. The root development of the plant exercises a preponderating influence on the good or bad nutrition of the bolls and, therefore, on their subsequent good or bad opening. From the daily records, he states, it was found that no one climatological factor could be held solely responsible for failures, but that each year a number of unfavourable factors operate at different times, and that it is the cumulative effect of these which is capable of causing failures. The Cotton Research Botanist believes that among the major factors which may operate are the following: an excessively hot and dry spell in the early part of the season, an abnormal number of dust-storms, puddling or water-logging of the soil due to heavy falls of rain, and late non-dehiscence of anthers, producing as a final result an undue competition between boll and boll for available nutrients, and also severe white fly attack consequent on a weakened resistance of the plant due to earlier unfavourable conditions.

There are, he thinks, other minor factors which prevail at different times and which co-operate with the major factors in destroying the crop. Various methods of ameliorating these conditions are suggested. For example an alteration in sowing date, good cultivation, and good agricultural practice. In the Punjab, he says, even under irrigation conditions, the climate is an arid climate, and it must be realised that the principles of dry-farming require to be applied. Consequently, the storing of water in the soil and the taking of every precaution to prevent water-loss from the soil are necessary. Also the reduction of weeds, green-manuring and, perhaps most important, suitable fertility-restoring rotations are all useful and desirable. It is, however, probable that the only really effective means of removing the possibilities of failures will be in the discovery of a type of plant which is constitutionally fitted to withstand the vagaries of climate and which can be relied upon

to produce, even under extreme conditions of environment, a properly nourished boll.

The following three investigations were carried out with the help of grants from the Imperial Council of Agricultural Research. A study of the physiology of the water-hyacinth was undertaken at Cuttack. It was found that seeds require a period of dryness before germination but if the testa of mature seeds be mechanically ruptured, the seeds germinate at once. It appears that seeds remain viable for four years. At the Royal Institute of Science, Bombay, the physiology of the rice plant was studied so far mainly with a direct view to cultivation, and the work done centred mainly on the manurial requirements of the plants. Valuable information has been collected on this particular topic. The osmotic and suction pressures were measured throughout the life of the plant, also the rise in those pressures on the addition of ammonium salts to the soil. Quantitative data have been collected about the intake of ammonium salts and the absorption ratios calculated. The photosynthesis, respiration and transpiration were also measured. Research on the effect of different ions on plant growth was begun at Lahore and so far the results indicate that a number of metallic ions, when added in the form of nitrates, affected the growth of the plants appreciably. Salts of uranium, thorium, cerium and iron showed an increased growth while those of lead and silver were found to have an adverse effect on growth.

A branch to study the physiology of tea was opened at Tocklai in the Scientific Department of the Indian Tea Association, and the work consisted mainly of collecting material, but it has not yet been found possible to examine all of it or to co-ordinate the data obtained. Work was also done to ascertain the distribution of tannin within the tissues of the plant. In this case a method had to be devised for fixing the tannin within the tannin-bearing cells before the material is prepared for microscopic examination. After a considerable amount of work, a successful method has at last been devised, and the results obtained by this method seemed to be considerably in advance of those obtained previously.

9. Plant diseases.

Rice. In MADRAS the investigation of blast caused by *Piricularia oryzae* was continued under four aspects : varietal resistance, the effect of manures, the effect of irrigation and morphological and histological studies. Among the fourteen varieties included in the trial, three have in three seasons exhibited a very high degree of resistance while the local rice and two other selections were found to be highly susceptible. An erect flag, a short neck, a compact panicle and an abundantly hairy ligule are factors associated with fungus attack. Indications were also obtained to show that the greater frequency of vascular bundles and the larger distribution of sclerenchymatous tissue were associated with disease resistance. Plants that received heavy doses of nitrogen were the first to succumb. Potash and phosphate showed slight inhibitory effect but not enough to save a susceptible variety. The effect of a restricted water-supply against ample irrigation was not significant. A foot-rot caused by *Fusarium* (*Cephalosporium*) on seedlings in the nursery was overcome by treating the seed in a 2 per cent. solution of copper sulphate for 30 minutes.

Wheat. A new bunt of wheat (*Tilletia indica*) was discovered by Dr. Mitra of Pusa. It occurred at Karnal in the Punjab on several varieties, both hybrids and their parents, among which were Federation and Punjab 8A. It was found to be fairly common in the grain of 8A stored in the Lahore grain market, so it is likely to occur in other localities in the Punjab. It is not easy to detect infected from sound plants, as the smutted grain remains enclosed in the husk. Usually it is only on being threshed that the smutted grains become evident. All the grains in an earhead are not usually infected and the disease does not at present seem to do very much damage. A sample of infected seed produced smutted plants in Karnal but not in Pusa, nor did artificially infected seed in Pusa. Besides the two species of *Helminthosporium* already known on wheat in India, a new species *H. vicolor* and a new variety of *H. halodes* were found from Poona and the other from the Central Provinces. In 1930 the variety P. 4 had 37 per cent. of its leaf-surface destroyed while the others ranged from 20 per cent. downwards to 3

per cent. Again in 1931 varieties P. 4 and P. 111 had twenty per cent. destroyed while P. 12, P. 52, P. 101, P. 163 and country wheat had three per cent. or less.

A survey of rust was made on all the varieties of wheat grown at Pusa. In 1930, P. 12 had 15 per cent. of its leaf-surface destroyed by orange rust, P. 80-5, P. 112, P. 111, P. 4 and P. 114 had from 7 to 3 per cent., while P. 52, P. 113 and Federation were free. As for yellow rust, P. 113 had 17 per cent. and P. 52 five per cent. destroyed and the rest were free. Black rust was severe on P. 12. The year 1931 was a light rust year. Pusa 12 and Pusa 4 had 11 and 9 per cent. of leaf-surface destroyed by orange rust, while the others had little or none. Yellow rust was 8 per cent. on P. 161, 4 per cent. on P. 162, 2.5 per cent. on P. 115 and P. 163, and only in traces or was absent on the others. Black rust appeared late and was present only in traces. At Karnal, on the other hand, P. 52 and P. 115 were so badly rusted that the grain was badly shrivelled.

The investigation of rusts on wheat, carried on at Allahabad and Simla under the auspices of the Imperial Council of Agricultural Research, has made considerable progress. It is now fairly well substantiated that uredospores of rust come from the Himalayas in the north and begin the attack each season in the plains of Northern India. There is also evidence that a similar thing happens in Peninsular India and that the uredospores come from somewhere in the Western Ghats. Overwintering occurs in the hills at fairly well defined levels for each of the three rusts, *e.g.*, yellow rust at higher altitudes, orange rust at intermediate altitudes and black rust at from 3,000 to 4,000 feet. Preliminary investigation seems to show that the number of physiological forms of rust on wheat are few. This investigation will provide most valuable information to the wheat-breeder.

A simplified hot water treatment for the control of loose smut has been successful in the Punjab in preventing this disease and was demonstrated.

In the CENTRAL PROVINCES black-tip and foot-rot, caused by species of *Helminthosporium* and *Ophionolus*, causes loss of varying

severity in different years. Forty-seven samples of wheat from farms in the province showed the presence of infected grains except in three samples and the percentage varied from 0.6 to 34. Germination was not affected even when the blackening extended beyond the embryo. The hyphae were found to be confined to the pericarp whence they spread to the first colourless leaf of the seedling and, when climatic conditions were favourable, the fungus spread to the roots and stems killing the seedling. Experiments continuously proved that the earlier the wheat is sown the greater the incidence of the disease. So it would appear to be best to delay sowing after the monsoon, till there is a drop in the air temperature. Plots sown as late as the first week of November gave as good yields in grain as those sown about the 20th of October.

Barley. The barley varieties grown in Pusa showed varying susceptibility to the leaf-spot caused by *Helminthosporium sativum*. A similar leaf-spot caused by *H. teres* was seen in Pusa for the first time, possibly introduced in seed from England or Nepal, and did more damage to the leaf-surface than the other one.

Cotton. In MADRAS the intensive study of the herbaceous cotton boll-rot and seedling blight caused by *Colletotrichum* was continued. Two weeds of the black-soil, *Aristolochia bracteata* and *Hibiscus ficulneus* were found to act as alternative hosts of the fungus. The eradication of these weeds may prove one of the means of controlling the disease. Following Ludwig's experiments in South Carolina on the control of cotton anthracnose, it was found that moist storage inhibited the disease but the seeds became musty and germination was poor. Dry storage did not reduce the disease but alternate dry and moist storage did reduce it. An attempt will now be made to test the utility of the method. Of six of the Cotton Botanist's strains tested one showed a high degree of resistance.

At Dharwar in BOMBAY attention has for several years been paid to the wilt disease. The nature of resistance to wilt in the cotton plants is not due to any peculiarity of structural differences in the roots of susceptible and resistant types for, while penetration of the fungus is common to both, its further progress in the susceptible

host is unhindered but is checked in the resistant one. The investigation has shown that the fungus is borne inside the seed and that fact indicates that in an organised seed distribution care must be taken not to take seed from a wilt-infected area to a wilt-free area that might be suited to the establishment of the fungus. This is in consonance with the experience in Texas where the state authorities have already taken action prohibiting the distribution of cotton seed from wilt-infected areas.

In the CENTRAL PROVINCES a physiological study was made of cotton *Fusaria* from Dharwar, Egypt and U. S. A., and the results so far obtained confirm Fahmy's conclusion that the three *Fusaria* are different. The seedling blight of cotton in these provinces rivals wilt in the damage it does. The cause was found to be *Rhizoctonia bataticola*, but *Rhizoctonia Solani* and *Pythium aphanidermatum* were also present. The varieties, Roseum, Buri and Verum 262 showed different percentage of alumina at different stages of growth. In plants two-months-and-a-half old, the percentage of alumina in Buri and healthy Verum is much more than in healthy Roseum ; as the plant grows there is a decrease in the alumina percentage in Buri and Verum, but an increase in Roseum. In young diseased plants of Verum 262, two-and-a-half months old, there is no marked increase in the alumina percentage ; but in old diseased plants, four-and-a-half months old, the alumina percentage is much higher than in healthy plants of the same age. In young diseased plants of Roseum, two-and-a-half months old, the alumina percentage is about twice that in healthy plants of the same age ; in old diseased plants of Roseum, four-and-a-half months old, the alumina percentage is higher than in healthy plants of the same age but the increase is not so much as in young diseased plants. From this analysis it is seen that the resistant varieties, Buri and Verum 262, when two-and-a-half months old, have practically the same alumina percentage as Roseum plants four-and-a-half months old. Whereas in the resistant varieties there is a decrease in the alumina percentage when they are four-and-a-half months old, in Roseum, a susceptible variety, there is an increase.

Sugarcane. The study of mosaic disease was continued at Pusa, in the Punjab, the United Provinces and Madras. Rogueing at Pusa for five years on 40 acres containing a large variety of Co. canes reduced the incidence, so that in 1930-31 only .002 per cent. of clumps were infected except in two plots of Co. 205 where the percentage was 0.8. Fortunately this very susceptible cane has been discarded because, in addition, it contains too much fibre, and Co. 285 is taking its place. Cane is not ratooned at Pusa. Rogueing is being done with some success in the United Provinces and the Punjab. In the Punjab and Madras, unlike Pusa, mosaic spreads rapidly. In 1930 in the Punjab, mosaic-free canes introduced into Lyallpur in April became 80 per cent. infected by October. Of 19 varieties of cane at Coimbatore Co. 205, Co. 214, Co. 244, Co. 314, Co. 315, Co. 316, Co. 318, Co. 335, P. O. J. 2878, Kassoer and P. O. J. 2714 showed either complete freedom from disease or a very high degree of resistance. The examination of the cuticle of three varieties, Co. 205, Co. 213 and Co. 223, did not show correlation between cuticle thickness and resistance. It was observed that secondary infection took place between the second and fourth months and gradually decreased till the seventh month after which it ceased altogether. A field experiment was laid down in 1931 to see whether there is loss in tonnage.

In 1930-31 an experiment in Pusa showed that the loss in tonnage of mosaic-infected cane was 4.6 per cent. in Co. 213, the most popular cane, and 8.6 per cent. in Co. 205. The quality of juice was slightly lowered in Co. 213 but did not show in Co. 205. Next year a similar experiment showed that the loss in tonnage of Co. 213 was 14.8 per cent. and the quality of the juice was again slightly lower. An examination of the Co. canes in North Bihar showed that infection on Co. 213 was only 0.2 per cent., so that so far the loss due to mosaic in this locality is very small. A similar experiment at Lyallpur showed that the healthy crop yielded 21 per cent. cane, 17 per cent. juice and 21 per cent. *gur*, more than the mosaic infected cane. This is a much larger difference than at Pusa.

A study of *Helminthosporium sacchari* at Pusa showed that it consists of several strains and saltants. This line of work is being

followed up to compare them with disease causing *Helminthosporia* in other countries. The strains and saltants cover a range sufficiently great to include, so far as the spore size is concerned, all the forms of *Helminthosporium* causing eye spot.

Smut is now almost absent from the farm at Pusa, only 7 cases being found in 1930. Through careful selection at planting time red-rot has been eliminated from the farm, not one case has been seen in 4 years. No fresh case of downey mildew has been found since the single case of 1929. The fungus infected cane, maize and *Euchlaena luxurians* artificially.

Millets. A species of *Striga* did considerable damage to *jowar* in the Central Provinces and it was found that some varieties were little affected whereas others were completely wiped out. Attempts to destroy this flowering parasite by ploughing at various times and by burning stalks of cotton and pigeon-pea on the field were not very successful. Early sowing in July, however, gave good results as compared with late sowing in that month.

Ragi. Two related fungi causing leaf-spot, seedling-blight, head-blight and foot-rot of *ragi* were found at Pusa to attack also wheat, oats, barley, *jowar*, *bajra* and grasses.

Potatoes. The efforts to reduce storage rot have been mentioned in Chapter II. The mosaic disease is a serious menace to the potato crop of the UNITED PROVINCES. Being very little understood by the cultivator, it has attained serious prevalence in his fields. The results obtained at the Research Farm conclusively show that this serious malady may be easily controlled by thorough and careful roguing and selection of seeds only from healthy hills. By this method the disease has been fully controlled at the Research Farm and has been brought down from about 70 per cent. in the course of four years, till in 1931 the crop from seed raised here gave perfectly healthy crop wherever grown. In MYSORE a promising start was made in the control of the *Alternaria* blight, a serious disease in the potato-growing areas of the State by means of Bordeaux mixture.

Beans and pulses. The selection of wilt-resistant strains of *rahar* at Pusa was successful. It was hoped to get an immune strain

but that may come yet. In the season 1929-30, seed of the resistant Type 80 was sown in the fourteen plots of the Permanent Manurial Series B, and in 1931-32 of Series A. The average number of wilted plants in each plot for the previous six seasons in which *rahar* was grown there, also the number in each plot during the immediately previous season and the number of wilted plants of the resistant type are given in the table below. As the number of wilted plants in the previous season (1927-28 and 1928-29 respectively) is much less than the average for the six seasons, it may be more reasonable to compare it with the result of those seasons. Summing all the wilted plants, it is seen that the totals of wilted plants are in the proportion 100 : 3·6 and 100 : ·05, respectively.

Number of wilted plants.

Plot	B.—SERIES.			A.—SERIES.		
	MIXED FARM SEED	RESISTANT TYPE T. 80		MIXED FARM SEED	RESISTANT TYPE T. 80	
		1927-28	1929-30		1928-29	1931-32
I	55	22	0	382	467	0
II	98	72	7	397	350	0
III	326	340	17	292	213	0
IV	935	807	39	567	382	0
V	207	133	2	240	160	0
VI	298	142	3	175	167	0
VII	357	110	6	190	96	0
VIII	1,138	483	13	1,000	912	1
IX	1,012	350	7	1,186	987	0
X	830	240	7	1,325	1049	0
XIII	175	48	2	267	127	0
XIV	272	113	3	195	151	0
XV	120	64	6	292	213	0
XVI	605	670	19	567	382	2

Partial sterility disease, which causes sterility on one or all branches of a plant, was investigated at Sabour and Pusa. It is fairly common in Bihar. Seeds did not transmit the disease. Juice from four sterile branches injected into 200 plants did not produce the disease. Certain pure lines are less susceptible than others. Three Sabour types and two Pusa types were practically free from the disease so that there is material to replace local susceptible types while the investigation of the cause is proceeding.

Gram. The study of the leaf-blight (*Mystrosporium*) was continued on 95 pure types of gram and five have remained free. So far the disease has been found only in Pusa, there being no trace of it in Sabour, Lyallpur and Coimbatore. It was found that steeping in 15 per cent. formalin kills all spores adhering to the outside of the seed and the fungus was not found inside the seed. Wilt caused by *Fusarium*, collar-rot caused by *Rhizoctonia* and *Sclerotium* were also investigated.

In the Punjab the practical result of the study of a gram blight, whose causative fungus *Mycosphaerella pinodes* is closely allied with that causing a similar blight in Southern Europe, was that the provision of uninfected seed from another district where the disease had not appeared was a sufficient control, but this has to be done on a large scale to prevent re-infection.

Wilt is the most important disease of gram in the Central Provinces but the *Fusaria* so far isolated from diseased plants have not reproduced the disease, hence it was suspected that a fungus may not be the real cause.

Wilt of groundnut, black gram and gingelly, caused by *Rhizoctonia bataticola*, was studied at Coimbatore. The erect varieties were more susceptible than the spreading ones. In 28 varieties the percentage of infection varied between 1 and 28, the variety Sugathur being the least susceptible. This disease was also found in the Central Provinces where it was observed that the variety Akola 10 was little affected.

Betel. The collar-rot of *Piper betel* has been studied in Pusa, Dacca, Nagpur, Poona and Mandalay. At the first three places the disease is believed to be caused by *Phytophthora parasitica*. In Bengal, Bombay, Burma, and Central Provinces, Bordeaux mixture has been found to be a preventive but, in the first locality, only when there is not too much flooding. The disease has also been located in Central India. In the cold weather in Bengal another fungus *Rhizoctonia solani* does much damage but can be controlled by a weak solution of kerol applied to the soil. *Sclerotium refsii* also does some damage and there is indication that it too can be controlled in the same way. Above all things, careful

sanitation is necessary to destroy all infected materials. A mildew of *Piper betel* in Burma was controlled by sulphur dusting.

Coffee. In Mysore, the spraying of coffee estates for the control of the three important diseases, black-rot, leaf-disease and die-back, has shown a very marked increase. It is estimated that about 6,000 acres were sprayed during the year 1931 against an estimated 3,000 acres for the previous year. Even with the reduced price of coffee that is now prevailing this has, on estimates received from the planters concerned, given a net increase in value of crop amounting to at least Rs. 3 lakhs. The operations against *areca koleroga* and coffee diseases together must have given a net return to the growers in the neighbourhood of Rs. 10 lakhs or nearly twice the total budget allotment for the Mysore Agricultural Department proper. The rapid increase in spraying more especially on coffee estates has made it imperative that thorough investigations be made on the efficacy of different types of spraying apparatus, of different spray mixtures and of adhesives. The results so far indicate that resin-soda, first introduced by the department in 1909, is a much more effective adhesive than lime caseinate which is now generally used. A particularly promising new adhesive in the form of linseed oil has been tried on a large scale. This appears likely to replace the lime caseinate adhesive and seems certain to increase greatly the effectiveness of the spray. It may be possible through the use of a more efficient adhesive to decrease materially the strength of the spray used and so to decrease its cost. This is a matter of very great importance at the present when the low prices ruling necessitate the most economical use of money possible in connection with all agricultural operations. The Scientific Officer of the United Planters' Association who is attached to the Coffee Station, has investigated the seasonal variation of coffee leaf-disease. His results have recently been published giving definite information as to the seasons and conditions under which leaf-disease spreads and most valuable information as to the time when spraying must be done to give satisfactory results. It was definitely established that at a certain stage in the life-history of the fungus it permeates the leaf tissue.

Areca nut. For spraying areca nut bushes in Mysore, materials were supplied to spray 4,900 acres or about two-and-a-half million palms, and a new type of nozzle was introduced which added to the efficiency of spray while not seriously affecting the spread of the operation, a most important factor owing to the limited time available for spraying during the monsoon.

Tung tree. In Bangalore, an interesting *Phytophthora* probably a strain of *P. palmivora* Butl. was isolated from *Aleurites fordii* (the Tung oil tree) seedlings growing in the laboratory compound at Bangalore. The seeds were got from Kew and the seedlings were about four months old at the time the infection was noticed. Infected leaves show leaf-spots, at first limited by the prominent veins, and later spreading to the whole leaf. Affected leaves finally drop down. Inoculation with the zoospore suspension on the under surface of healthy leaves was successful and the fungus was re-isolated.

Bordeaux mixture was also used effectively against a bark-rot of citrus in the Central Provinces, and in the Punjab citrus canker, a disease caused by a bacterium, was said to have been effectively controlled by spraying with Bordeaux mixture (4 : 4 : 50). Sulphur dusting was used with good effect in Bombay for rust of *jowar*, powdery mildew of grapes and of peas, rust of figs and red leaf blight of cotton; and in Madras, Bombay and Burma for grain smut.

10. Entomology.

Locusts. The study of the locust problem in this country was placed on a stable footing by the acceptance of the recommendations of the Board of Agriculture, which met at Pusa during December, 1929. The Locust Bureau was instituted by the Imperial Council of Agricultural Research and locust intelligence was received, compiled and distributed regularly from the beginning of March, 1930. Since December, 1930, a scheme of locust research, financed by the Imperial Council of Agricultural Research, has been in operation. Studies on the different aspects of the locust problem are in hand. A scheme of survey has also been initiated to discover the permanent breeding grounds of this pest, and survey

parties have already visited various parts of Baluchistan and the Sind Valley, and have discovered solitary locusts in various parts from Jacobabad to Karachi, in the interior of Baluchistan and along the Mekran Coast. During 1932 breeding under natural conditions was going on at Pasni, where a field laboratory has been established to study locusts in their natural surroundings.

A brief history of the recent locusts outbreak that started in 1926 and culminated in 1930 may not be out of place. There is definite information of adult locusts being found in Las Bela State in August and in Karachi and Tharparkar Districts of Sind in September, 1926. These fliers must have originated from the eggs laid during the spring from February to May. This suggests the extensive presence of over-wintered fliers during 1925-26. Hoppers were actually noticed in the river Hub (Karachi) in November. These had developed from the eggs laid in July, August and September. Thus breeding was undoubtedly going on in parts of Baluchistan and Sind in 1926. From September onward the fliers of the second brood started appearing and spread over Sind. By December 1926, the fliers had reached Punjab, and by February 1927, they had spread over the greater part of the province except the south-east. Simultaneously locusts were spreading over Rajputana. By March they had further spread over south-east Punjab and the United Provinces. A flight had reached Pusa in Bihar by the beginning of July 1927. During 1927 eggs were laid over a greater part of this area in March and April and again in July and August. From 1928 to 1930 the intensity of infestation increased and was at its highest during 1929 and 1930 when both the broods of locusts developed over the extensive tract comprising Baluchistan; Sind, Rajputana, the Punjab and the United Provinces. They did enormous damage.

During February and March, 1930, locusts were present and laying eggs in the eastern and southern parts of the Punjab and in the western part of the United Provinces. They were also breeding in Baluchistan and Sind. By the end of May the newly hatched fliers had spread over the greater part of the Punjab and United Provinces and gone as far east as Gorakhpur and as far south as

Rewa. During June they reached as far east as Patna and Ranchi and were present in Bhopal. During the next two months, *i.e.*, the monsoon season, they disappeared from the eastern portion of the United Provinces and were restricted to the Punjab and the most western parts of the United Provinces. After the monsoon season they once more extended their area of distribution and went as far as Akola in the Central Provinces, and also reached Warangal in Hyderabad and Rangpur in Bengal. During October and November they were present in the Punjab, Rajputana, the Western Indian States and Central Indian States, and were reported from Bombay and Ranchi. In December they were reported from Lakhimpur in the extreme north-east of Assam. During 1930 they reached the extreme limits of their distribution in India, but died out in these inhospitable regions.

In 1931 the attack was very mild. Up till June the locusts were confined to Baluchistan and Southern Sind, and occasional reports were received from the Punjab and Ajmer. During July, however, the swarm visited south-eastern Punjab and north-western United Provinces, and extended towards the west to Baluchistan. Frequent reports were received from Rajputana. This continued till the end of August. From September onward the area of locust distribution decreased and during October to December locusts were only reported from western Rajputana, Sind, eastern Baluchistan and along the Mekran coast.

During 1932 the swarms were only reported from a few places in Baluchistan. The field laboratory at Pasni reported a swarm in June, coming from the north-east. Reports were also received of thin swarms from some of the Western Indian States. Since June no swarms have been reported.

From this brief survey it appears that the locusts originated in Sind and Baluchistan and successive waves of invasion having reached the Punjab, United Provinces, Rajputana and other parts of India, died out ; and locusts were finally restricted to the Sind-Baluchistan area again, which perhaps with certain parts of Rajputana, forms a permanent breeding ground of *Schistocerca gregaria* in India.

Other Insect pests—Sugarcane. From an account of a large series of egg-masses at various periods of oviposition, it was seen at PUSA that only a very small percentage of borers entered the newly planted canes. By the end of June *Emmalocera depressella* and *Diatraea* spp., especially *Diatraea venosata*, Wlk., were the predominant borers. The bionomics of these and an intensive study of their egg-parasites were under investigation. A series of examinations with a view to ascertaining the incidence of attack of borers and termites were made. One thousand canes each of Co. 213 and Co. 205 which had been planted in February were examined in December 1930 with the following result:—

—	Undamaged	<i>Scirpophaga nivella</i>	Stem Borers	Root Borer	Termites
Co. 213 . . .	7.1	73.2	23.5	27.7	66.9
Co. 205 . . .	14.1	80.3	8.3	39.0	33.0

Again the following varieties Co. 205, 210, 213, 214, 223, 281, 285, 287, 290, 295, 297, 298, 299, 301, 302, 303 and 305 planted in February 1930, were examined for borers and termites before their despatch to the crushing mill. Of these the top-shoot borer, *Scirpophaga nivella*, was found to be bad in the following, viz. :—

	Per cent.
Co. 205	83.3
Co. 210	85.0
Co. 214	83.4
Co. 301	95.0
Co. 303	81.6
Co. 223	50.0

As regards the stem-borers (*Diatraea venosata*, *Argyria sticticraspis* and *Chilo zonellus*), Co. 213 suffered the most (15.5 per cent.) and Co. 231 the least. Termites had attacked Co. 214 the most (16.8 per cent.) and Co. 299 the least (7.7 per cent.). It was found that the eggs of the top-shoot borer were actively parasitized during March and April. The effect of the continuous collection of the egg-masses has given tangible results and is within the capacity of the

cane-growers in all areas. The root-borer (*Emmalocera depressella*) was very active from the beginning of May to the middle of June, being the principal borer at this time when the other borers are rendered rather quiescent by the high temperatures prevalent. By the third week in June, it was found to be parasitized by a Braconid. A study was made of the alternative hosts of cane-borers especially wild grasses. In MYSORE one of the most promising items of work was the mass-rearing of an important egg parasite of various serious moth borers. Liberation will have to be carried out on an extensive scale before the effect of this method of borer control can be judged and this will be undertaken at once.

In the PUNJAB, the study of the relative extent of damage done by sugarcane borer to different varieties of sugarcane was continued and one highly susceptible variety showed damage as high as 90 per cent. In the vicinity of Gurdaspur sugarcane fields were attacked to the extent of 25 to 30 per cent. By way of control, the removal of the damaged central shoot and treatment of the cavity thus created with petrol spirit or derrisol resulted in a mortality to the pest varying from 90 to 30 per cent. It was found that individuals of the sugarcane *Pyrrilla* lived for about a hundred days between November and March: thus it appears that they can live through the Punjab winter as adult insects. It was also found that this pest had a variety of food plants including wheat, oats, guinea grass, several wild grasses and this adds to the difficulty of its control.

Rice. In Ganjam and Malabar rice grass-hoppers (*Hieroglyphus banian* and *H. orizivorus*) do serious damage. Badly attacked fields look as if they had been grazed down to stalks a foot high. Ploughing where possible from January to March and scraping the bunds to a depth of 3 or 4 inches dislodged and brought to the surface the egg-masses which were destroyed. The effect was good but the operations have to be carried out over a large area to be effective. A study of the mealy bug of rice in Tanjore was taken up and work was done on the blue beetle of rice and also a small bug, *Nilaparvata lugens*, in Malabar. As the last named bug had the habit of jumping down from the plants into the water

below on the least disturbance, advantage was taken of it by kerosenating the surface of the irrigation water and then dislodging the bugs, whereby most of them were caught in the oil film and destroyed.

In the PUNJAB, investigations on the life-history and seasonal cycle of the rice stem borer were continued. A study of the comparative damage done to the early and late-sown rice showed that in the early-sown crop the percentage of attack varied from 1 to 19 per cent., whilst in the late crop it averaged from 38 to 87 per cent. In the early crop the number of borers hibernating in the stubbles was found to be 37 per thousand stubbles, whilst 352 were found in the case of the late crop. Rice plants growing under shade were found to be much more damaged than those growing in the open. Similarly infestation of the crop growing on low-lying places was higher than that on level fields. The work done up to the present seems to show that burning of the stubbles *in situ* is not a sufficient method of controlling this pest. Many of the caterpillars seem to hibernate below ground level. The only effective remedy so far appears to be ploughing up the land, collecting the whole stubbles and burning them. In BURMA, the rice hispa which did widespread damage in Pegu and surrounding districts and *Erotylid* grubs from Bhamo districts were studied.

Cotton. In MADRAS counts were made to find out the comparative intensity of stem-weevil attack on areas where the Pest Act was enforced in the Pollachi tract during the year. Generally, the weevil infestation has been found to be comparatively less in villages where the Pest Act was enforced. Counts taken in December and January 1930 showed the existence of 67 per cent. attack on Cambodia cotton and 24 per cent. in the country cottons. The percentage of deaths was however low. In April the percentage had risen to 96 in Cambodia, while in the indigenous cottons it rose to 59 per cent. This year the incidence of attack seemed to be very high.

In the PUNJAB, the scheme for the investigation of pink bollworm financed by the Indian Central Cotton Committee originally for a period of five years, was further extended for another two

years. The relationship between climatic factors such as temperature and humidity and the intensity of attack of this pest and its distribution over the province, the influence of temperature on oviposition and egg-hatching, the sources of infection and phototropism are being studied. Observations on the bionomics and alternative food-plants of spotted bollworm were continued. It was observed that the flower buds and fruits of the alternative food-plants of spotted bollworms, such as *bhindi* and hollyhock, attracted a large number of these insects throughout the fruiting season. The preliminary work carried out by the Indian Central Cotton Committee's research scholar at Khanewal and Lyallpur on a study of the white-fly of cotton showed that although it is improbable that this fly is the main cause of the cotton failures which have occurred in the past, it is nevertheless a serious pest of the cotton crop. The Indian Central Cotton Committee, therefore, have financed a research scheme to work out the life-history and control measures for this pest. The preliminary work established the fact that 12 generations of this pest were produced in a year. The average duration of the life-cycle of this insect from April to September was 17.5 days, while between November and February it was prolonged to a maximum of 97 days. The migration of the pest from Deshi to American cotton and *vice versa* was investigated as also the nature of the damage caused to the cotton plant by it. As far as research into control measures has proceeded at present, the spraying of the cotton crop with rosin compound, once in July, August and September, gave the best results, but is as yet inconclusive.

The chief work of the Entomological Section in the UNITED PROVINCES was the investigation of the damage caused by the pink bollworms and of methods for preventing it. Experiments and observations have shown that the only serious source through which the cotton crop of the United Provinces becomes re-infected by the pink bollworm is the seed. The caterpillar remains dormant in the seed between harvest time and sowing. The sown seed thus contains the living worms which later turn into adult moths which lay their eggs on the growing cotton plant. Any unsown seed which

is kept until the monsoon also produces moths that fly to the cotton fields and spread the infection. Thereafter multiplication is very rapid, so that by the time the plants are nearing maturity there may be hundreds of thousands of the worms in an acre of the crop sufficient to cause injury to nearly every boll. Pink bollworms are killed almost immediately at 140°F., a temperature which does not in any way injure the germinating capacity of the seed. They are killed also at temperatures as low as 125°F. after prolonged heating. During the later part of March and months of May and June the heat of the sun is sufficient to raise the seed to the lower lethal temperature. In field experiments sun-heat is utilized for pink bollworm control but the larger stocks of cotton seed from the ginneries still remain a very important source of re-infection. For these mechanical heat-treatment in the ginneries is required. General co-operation of cultivators within the controlled area is necessary for an effective control of pink bollworm by using sun-heat. It is further necessary to insure the co-operation of all holders of stocks of cotton-seed for cattle-food or other purposes. Provision of sufficient treated seed for cattle-food as well as for sowing throughout the controlled area is essential for effectively combating the pink boll pest. Field control of pink bollworm was carried out in two areas : one in the Tarai jungles of Najibabad tahsil of Bijnor district and the other in the whole of Atrauli tahsil and a portion of Koil tahsil in the Aligarh district. The additional yield per acre in the controlled area was two maunds in Najibabad and about three maunds of *kapas* in Aligarh. The whiteness and freedom from infection obtained a premium of about Re. 1 per maund above the price of *kapas* from untreated areas.

Fruits. In MADRAS work was done on the mango hopper, fruit moth of orange, the grape vine beetle, and the wooly aphids of the apple. In the PUNJAB, investigations on the citrus white flies brought to light 7 species. Observations on the bionomics of the San José Scale were made in Kulu and extensive spraying operations were conducted and proved a valuable means of control. During this investigation it was discovered that wooly aphids did much damage but it too can be controlled by spraying. In the Kumaon

Hills wooly aphid is the most serious pest of fruit trees and its life-history was thoroughly studied. Brushing or spraying with kerosene, caustic soda and lime sulphur kills the aphid but it is most difficult to get all the cracks in the bark treated. Wooly aphid was not seen on Northern Spy and London Pippin.

Coffee. Information came to notice at the close of 1929 that the coffee berry borer, *Stephanoderes hampei*, had been found on coffee from Indian coffee estates. Immediate steps were taken by the Director of Agriculture, Mysore, to verify this information and to ascertain the spread of the pest. An attempt was also made to enlist the co-operation of all Governments and organisations interested in coffee cultivation, as it was felt that independent efforts by different Governments could not lead to successful control. A bulletin was prepared by the Entomologist for general circulation throughout South India giving the main facts known with regard to this serious pest of coffee and the work of organising investigation and control measures was being taken up actively.

A notification was promulgated in April 1931 prohibiting the importation of foreign coffee into India unless it be roasted or ground with a view to preventing the entry of this coffee berry borer.

Another important and promising line of work has been the investigation of various fish poisons with reference to their insecticidal value. There are a large number of plants growing in the Mysore jungles which furnish fish poisons and it has been demonstrated already that some of these are effective as larvicides for mosquitos and for use as sprays against plant lice. It also appears probable that they can be used for the making of sheep dips and to kill insect ectoparasites of other domesticated animals. An attempt is being made to isolate the active principle or principles of these fish poisons. Work of a somewhat similar nature is being done with seed which yields hydrocyanic acid in fairly large quantities. Attempts are being made to use this to control insects attacking stored grain and other stored products and also as soil disinfectant.

11. Useful insects.

Lac. On the recommendation of the Indian Lac Association and the Government of Bihar and Orissa, the Government of India decided in 1930 to dissolve the Indian Association for Lac Research and to transfer the future control of lac research to a Statutory Committee with powers to receive and expend the proceeds of the lac cess. A Bill to this effect was passed by the Legislative Assembly in July 1930. The Annual Report of the Indian Lac Association for Research shows that at the Lac Research Institute, Namkum, Ranchi, the well-conceived programme laid down during the time of the previous review has made satisfactory progress. Not only have the agricultural, entomological and chemical aspects been studied further but the investigation into the physical characters of shellac has made available knowledge useful to the consuming industry. A further development consists in a proposal to have this aspect of the subject studied more intensively in close proximity to the manufacturing areas.

On the plantation side, seven host plants were studied and experiments on suitable systems of crop-rotation, pruning of the host plants and manuring were continued. The result of liming the soil under *Acacia catechu* showed an increase in the lac crop. A comparison of the yields of scraped lac from each of the permanent manurial plots showed that the highest yield was obtained from the one receiving a complete manure (ammonium and potassium sulphates and superphosphates). On the bio-chemical side, the comparative study of good and bad lac hosts was continued with a view to study the factors that influence the suitability or otherwise of a plant to serve as a host as well as the actual food requirements of the lac insect and the depletion of these substances in the host plant. Experiments with cross infections so far indicate a marked improvement in the qualities of resin-producing efficiency, mortality and sex ratio. Work on the nutrition of the lac insect was continued by making chemical analysis of lac-bearing and non-lac-bearing shoots of various host plants, inorganic analysis of lac encrustation and insect bodies and periodical analysis of the soil

in a lac-growing area. It is hoped in this way to obtain information concerning the actual food requirements of the lac insect and the depletion of these substances in the host plant. Results from work of this type should eventually yield data showing how frequently any particular host can be cropped without deterioration and also what it is necessary to return to the plant in order to obtain the maximum number of crops from it.

On the technical side, an examination of the physical and chemical properties of certain stick lacs was undertaken and this should give valuable information as to the influence of the properties of stick lac on the properties of the manufactured product and, therefore, on the grading of stick lacs for different types of shellac. Another line of investigation that was taken up was to find out the effect of heat treatment on lac. This is a problem on which very little information is available and it is important, as the comparatively low softening point of shellac militates against its use for electrical insulation purposes. Hence an attempt is being made to evolve a shellac which, while possessing the essential properties of ordinary shellac, has a much higher softening point. The results of the investigation of the action of water and various chemicals on shellac films prepared from various mixed solvents has been published. The general conclusion arrived at from an examination of the work in the factory was that with suitable supervision as regards cleanliness, etc., at least 70 per cent. of the shellac manufactured in India could be fines and superfines provided the stick lac was not more than a year old when it got to the factory. The actual cost of manufacturing such superfine lac would not be more than the cost of manufacturing T. N.'s, for the fluidity of good quality, young, stick lac, shortens the time of melting very considerably with appreciable saving in expense, and crushing and washing losses are low. Unfortunately, however, so long as the price of shellac is fluctuating, the practice of storing stick lac for long periods will be resorted to and the ideal conditions whereby stick lac is cut, manufactured into shellac and exported to a cooler climate with as little delay as possible will not be realised. It is a point worthy of strong emphasis that stick lac, washed lac and shellac,

while stored in a hot climate are very rapidly polymerising and deteriorating in quality and in three or four years are almost ruined for many industrial uses. This rate of polymerisation is accelerated by increasing temperature. In cool climates it is relatively slow and in cold storage it is practically zero. It is obvious that, if the initial high fluidity of the lac is to be retained in the shellac, the time the material is kept in India, either as stick lac or shellac, should be reduced to a minimum and such storage as is necessary should be done in as cool a place as possible. It may be pointed out that this property of high fluidity is of the utmost importance to the moulding and gramophone industries which take over 50 per cent. of the exported shellac.

Investigation on the entomological side falls into two main groups, firstly the bionomics of the lac insect and secondly the insect enemies and friends of the lac insect and its host plants. A great deal of useful information has been acquired and made available, one item of which is an improved and simpler method of forecasting emergence. The average annual damage by insects to the lac crop is said to be in the neighbourhood of 60 per cent. so that the investigation of insect enemies of lac is an extremely important problem. It is essential that their life-histories and relationship with the lac insect be thoroughly understood and such work has been an important line of investigation. Fortunately several predators and parasites of these harmful insects are also under study with a view to their exploitation in a good cause.

12. Sericulture.

The sericultural industry in India is undergoing a period of stress owing to competition from China, Japan, France and Italy in the real silk market and also severe competition from artificial silk, and the general policy of the departments in those provinces and States --Bengal, Madras, Mysore and Kashmir—is to show the rearer how to lower the cost of production sufficiently to be able to meet competition.

In BENGAL there were twelve nurseries in 1929 and one less in 1930, mainly engaged in the production of pebrine-free seed which is

partly sold direct to rearers for commercial cocoon production and partly to selected rearers (mostly passed students of the sericultural schools) who carry out one multiplication under departmental supervision before selling the produce to the ordinary rearers. The produce of government nurseries was 16 tons in 1929 and 22 tons in 1930, while that of selected rearers was 22 tons in 1929 and 21 tons in 1930. The total production now represents about half the total sericultural seed requirements in Bengal. The Department is now in a position to make recommendation regarding the effect of manuring on increasing the production of leaf and cocoons. Artificial farmyard manure was manufactured on a practical scale at all nurseries and there was universal testimony to the value of this method of utilizing all refuse organic matter at so low a cost. Stabilised bleaching powder was successfully used as a disinfectant instead of formalin. Now a rearer can thoroughly disinfect his rearing shed and apparatus at a cost of one or two annas. Pure strains of the race Chotopoulu have been obtained which seem to do well in the environment where their ancestors existed but not elsewhere. On this account each nursery is trying to rear its own special strain.

Eri which feeds on castor appeared to have prospects in Howra, Bogra and the Chittagong Hill tracts where rearers prefer it because the food plant is less liable to be eaten by cattle.

A scheme for modernizing the reeling, doubling and twisting machinery of the Berhampore Silk Weaving Institute was drawn up with a view to making the Institute a nucleus for such improvement of Bengal silk as will enable it to compete on equal terms with imported yarn. During 1929-30, 1,682 cases of epidemic disease were reported of which 1,460 were successfully checked, representing a saving of about Rs. 44,000 to the rearers. The corresponding numbers in 1930-31 were 1,471, 1,289 and Rs. 58,000. The failures were entirely due either to negligence of the rearers or to delay in reporting the outbreak. The operations of the sericulturist demonstration staff in the villages continued and the Bengal Co-operative Silk Union continued to flourish.

On account of the low prices and unfavourable seasonal conditions the area under mulberry in the MYSORE STATE declined from 46,572 acres in 1928-29 to 43,634 acres in 1929-30 and then to 42,880 acres next year. To meet the situation, the Department intensified its propaganda and sericulturists were advised to lower the cost of production by restricting their rearings according to leaf-supply, by using quicker and higher yielding cross-bred strains and by timely attention to cultural operations. The government grainages supplied to silk farms and sericulturists 9,79,000 D. F. layings during 1929-30 and 12,17,650 during 1930-31; of these hybrids and pure races amounted to 3,24,015 in 1929-30 and 2,97,332 in 1930-31.

The preparation of cross-bred layings was handicapped for want of a sufficient supply of pure foreign races but arrangements have now been made to obtain fresh stocks every year. In addition to government grainages there were 5 aided grainages in 1928-29, 11 next year and 13 in 1930-31. These grainages in their turn supplied 298,648, 689,207 and 1,241,456 of layings in the respective years. The 460 selected rearers in 1929-30 and 496 in 1930-31 put on the market 140 lakhs and 350 lakhs respectively of prepared cocoons.

Experimental work was continued at the Central Farm at Mysore and Chennapatna on the rearing of foreign races and hybridization. The eggs of new races obtained from Japan gave uniformly good results by themselves as also in combination with the Mysore race. Experiments with the hybrids were continued and work was started to improve the Mysore race by selection. Rearing experiments with mulberry leaves plucked early in the morning and late in the afternoon showed that the afternoon leaves were more nutritious than the morning leaves. Experiments in mulberry cultivation consisted of grafting of several foreign varieties on Mysore mulberry, manurial experiments, improvement of the cultural operations, isolation and multiplication of local male mulberry and spraying experiments with a solution of potassium sulphide to eradicate mildew in mulberry. The Japanese varieties of mulberry have been propagated by marcottage, layering and budding as it was found difficult to propagate them by cuttings.

Experiments were started to study the quality of silk produced by the cocoons of several combinations with foreign races. Facilities were given for training in the several farms of the Department, the trained men being encouraged to start aided grainages.

Owing to the continued depression in the silk trade, the Department had to increase the amount of sericultural loans during the year 1930-31, the total sum advanced being Rs. 12,715. The Mysore Silk Association took an active interest in the advancement of sericulture in the State ; it organised a co-operative society for the joint sale of silk produced at the domestic basins and issued a fortnightly bulletin giving market prices of silk, cocoon, etc.

In MADRAS work was confined to cultural experiments of mulberry, hybridization and distribution of disease-free seed. A number of successful crops of French univoltine and Mysore races were raised at Conoor. The Hosur Silk Farm, started in 1929, raised successfully in 1929-30, 31,120 seed cocoons and in 1930-31, 2,90,343 cocoons from which disease-free layings were prepared and sold to rearers.

The peripatetic rearing party stationed in Kollegal district, continued to render assistance to the rearers by moth-testing at their houses, giving instructions in the use of microscopes, assisting literate rearers in the starting and maintaining of grainages and in the installation of improved types of reeling machinery. 2,34,999 layings in 1929-30 and 1,89,843 in 1930-31 were tested by the party.

In BURMA the sericultural operations are centred round the nurseries at Maymyo, Mandalay and Paukkaung in the Prome district. The main work of Maymyo nursery is to receive superior foreign races of univoltine silk worms for crossing with indigenous multivoltine races. The hybrids produced at this station are reported to have largely replaced the local multivoltine kind. Experiments on the pruning and manuring of mulberry were also carried on. As a result of the observations made by the Entomologist during his study leave in Japan, the practice of the grafting of mulberry has been introduced. During 1930-31 ten races were imported from Japan and were maintained in addition to the several crosses produced at the station. Two-thousand-six-hundred-and-

sixty seed cocoons and 120 layings in 1929-30 and 5,355 seed cocoons and 608 layings in 1930-31 were supplied from this station. The nursery at Mandalay is maintained to transfer the worms from Maymyo to a warmer climate in the cold weather. The Paukkaung nursery was opened with the idea of resuscitating the silk industry which once flourished in that locality, but several of the attempts made by the Department to give a training in sericulture to the local people have so far proved a failure. The Mission nursery at Leiktho continued to function with the assistance of the Department.

ASSAM. The Sericultural Section of the Industries Department maintained two sericultural stations, one at Titabar and the other at Shillong. Three species of silk worms were reared at the Titabar Station, *viz.*, *Eri.*, *Pat* and *Muga*, and the yield records showed that in regard especially to the univoltine French brood, the Shillong stock gave much better yield in the number of cocoons and the silk content than the Titabar stock. The Shillong Station appears to be particularly suited for rearing purposes; a univoltine variety which gave a yield of 14.5 grms. per 100 cocoons at the Titabar Station, gave at Shillong an yield of 38 grms. per 100 cocoons. As a result of the successful propaganda work conducted by the departmental staff, silk-rearing is reported to be extending in the province.

CHAPTER IV

AGRICULTURAL ENGINEERING.

1. Hydraulics.

In the UNITED PROVINCES where strainer tube-well construction has been in progress for several years and where 248 large tube-wells suitable for power pumping plant and about 200 smaller ones have been installed for private individuals, the Engineering Section has been completely reorganised and is now in a better position to undertake its work promptly and effectively. In 1928-29, the number of tube-wells constructed was 71, comprising 27 tube-wells of 6 inches and over and 44 smaller ones. In 1929-30 the total number was 39, consisting of 17 tube-wells of 5 inches and over and 22 strainer wells of $3\frac{3}{8}$ inches. In 1930-31, 129 projects were completed consisting of 34 tube-wells of 5 inches and over, and 95 of $3\frac{3}{8}$ inches, while 146 projects comprising 70 tube-wells of 5 inches and over and 76 strainer wells of $3\frac{3}{8}$ inches were in progress. The smaller outturn of work in 1929-30 was attributable to a large extent to the lack of *takavi* allotments due to the very large amounts of *takavi* loans given out for seed and bullocks. In 1930-31, a substantial improvement was shown in the volume of work undertaken. The most successful tube-well in 1929-30 was a 10-inch diameter work with a discharge of 533 gallons per minute and a characteristic of 62.74 gallons per minute per foot depression, and, again, in 1930-31 a 10-inch well with a discharge of 894 gallons per minute and a depression of 18 feet 5 inches. On calculating the running costs of tube-well installations, it has been found that the bigger wells are cheaper than the small ones, the cost of water being 0.68 annas per thousand gallons in the last-mentioned well. The following important projects were on a more ambitious nature than those hitherto undertaken, *viz.*, a tube-well in Moradabad to irrigate $4\frac{1}{2}$ square miles, a pumping scheme on the Bhakra river to control 1500 acres, another on the Ken river for 1000 acres, a third on the Pathri river to command 950 acres and a fourth on the

Rapti river for 650 acres. There is immense scope for private irrigation schemes of this kind from rivers, though with the exception of a few in Gorakhpur district there are practically none in the province. Tenders have been accepted for the electrification of tube-wells in the electric grid area and it is anticipated that the successful completion of these installations will make electrification of tube-wells more popular.

With the introduction of the "Brownlie" slip strainers, and latterly the "composition" slip strainer, the yields of many wells in the PUNJAB have been increased from one hundred to three hundred per cent. This success has created a rapidly growing demand for small power plants and active propaganda has been engaged in, to encourage this system of water lifting. At the same time the paramount importance of installing plants which cannot withdraw more water than the well will safely yield, has been impressed on land-owners. After many years' experience of sub-soil water-flow in the Punjab alluvial deposits, the Agricultural Engineer feels that he is in a position to determine with exactitude the discharge of water which can be taken from ordinary wells augmented by strainer tubes. Three deep trial bores were made, in one of which a plentiful supply of water was tapped at a depth of 404 feet but in the other two taken down to 332 feet and 509 feet, respectively, no suitable water-bearing stratum was found. The demand for the installations of small pumping plants in the Ferozepore Sub-Division has steadily increased and several bores preliminary to such installation were made. Yields of water varying from 3,000 to 15,000 gallons an hour were obtained from wells bored for this purpose under heads in no case exceeding the critical limits of the sub-soil. It is expected that this type of work will increase to a great extent, when cheap electric power from the Mandi Hydro-Electric Scheme becomes available. In BIHAR AND ORISSA, 24 tube-wells were installed in 1929-30 and 25 next year, of which 6 were 5 inches and over. There was some demand for power pumping installations on river banks and several portable pumping sets were supplied for the purpose. In BOMBAY, several power pumping plants were installed for cultivators and also at Government farms

and schools, wherever there was a possibility of demonstrating a power pumping unit.

2. Well-boring.

In most provinces the agricultural departments continued to maintain a staff for the improvement of village wells by boring and for trial bores in connection with the construction of new masonry wells for irrigation and general agricultural purposes.

In the UNITED PROVINCES, the number of borings made in existing and in proposed wells was 1,543 in 1929-30 with 1,137 successes and in 1930-31, 1,442 with 1,070 successes. The total number of wells bored by the department up to date is 27,243.

The average cost per acre, assuming that ten acres are irrigated per well, was Rs. 34 in 1929-30 and Rs. 36 in 1930-31, and running costs ranged from annas 6 to Rs. 3-8 per acre of water. These figures bring out the fact that, except where the lift is small, such installations are only profitable in an intensive system of agriculture where valuable crops like sugarcane and tobacco are grown.

The system of carrying out tests on each well both before and after boring has been adopted in order that a definite measure of the improvement effected may be available. This system is already in practice in the PUNJAB where no boring is reported as successful unless the supply is increased by at least 20 per cent. In this province, 935 wells were bored in 1929-30 of which 786 were successful, while next year 887 were bored with 686 successes. In 1929-30, 475 of the wells were fitted with an average of 13.9 feet of strainer and in 1930-31, 449 wells had an average of 14.5 feet. This shows a tendency on the part of well owners to use greater length of strainer in the hope of obtaining a greater yield. In BIHAR AND ORISSA, the number of open small borings in 1929-30 was 323, of which 238 were successful and next year 222 of which 197 were successes. Forty small bores had to be abandoned as rock was met close to the surface. Proposals have been made for a small rock-drilling plant to investigate possibilities in the Chota Nagpur Division and adjoining areas. In BOMBAY, 78 borings were made of which 17 were unsuccessful. A good many were required for drinking water

rather than for irrigation, and boring was carried out under very difficult conditions, most of the unsuccessful ones being due to boulders. Boring operations in Bombay were closed down in November 1930 owing to financial stringency. An efficient soil-sampling outfit portable on a camel and having a collapsible folding derrick was designed for soil-sampling in SIND, where samples down to thirty feet were required in large numbers.

3. Lift Irrigation and Water-lifts.

The installation of the larger size tube-wells already referred to involved the provision of suitable power pumping plants. In the PUNJAB, lift irrigation formed a special division of the Agricultural Engineer's Section under the charge of an Executive Engineer. The Division deals primarily with the investigation of the possibility of irrigating areas not commanded by canal water either by means of tube-wells or pumping water from rivers. The work embraces the preliminary survey of the area, preparation of plans and estimates for the projects. During the four years of its existence, this Division collected some very valuable data regarding the flow of water through fine gravel and certain extensive schemes for the irrigation of large tracts of land in various districts of the province. Owing to financial stringency it was abolished in 1930. The possibility of driving a Persian wheel by electric power was investigated but so far the cost of reduction-gears was so high that attention was turned to the evolution of a centrifugal tubular pump for small discharges, and a pump has been designed and made up which will be tested and modified as found necessary in the coming year.

In MADRAS the Industrial Engineer erected 49 and 46 pumping plants in the two years 1929-30 and 1930-31 as against 51 in 1928-29, bringing 605 and 785 acres under irrigation. 304 and 298 power pumping plants were inspected and overhauled by his staff under the Industrial Department's maintenance scheme, under which the owner pays Rs. 10 per annum for three inspections. In BIHAR AND ORISSA two power pumping plants were erected in 1929-30, one delivering 20,000 gallons per hour and the other 38,000 gallons. Next year, two similar plants were

installed. The success of the demonstration with the portable pumping sets is creating a demand for this class of water-lift. In the CENTRAL PROVINCES a crude-oil engine driving a 3-inch centrifugal pump was installed to lift water 55 feet to irrigate 12 acres for sugarcane, oranges, plantains and vegetables.

4. Improved Water-lifts for Bullock-power.

The Persian wheel made of metal received attention in the Punjab, Bihar and Orissa, the Central Provinces and Bengal.. As a result of testing 69 various patterns in the competition mentioned in the last Review, a metal wheel of a high standard of efficiency and a reasonable price has been achieved.

In BIHAR AND ORISSA 25 Persian wheel pumps were sold by the department. Here, too, improvements have been made in the design and a number of local foundries have taken up the manufacture. Private manufacturers report that the demand for the Sabour type of water-lift has increased so considerably that the price has been reduced.

In the CENTRAL PROVINCES, Persian wheels are beginning to gain popularity and the department erected twelve of them. In BENGAL an improved bullock-driven pump for irrigation where the suction lift does not exceed 20 feet and another for lifts up to 50 feet as well as two types of Persian wheel for small and large bullocks have been designed. In MADRAS, improvements to the roll-easy mhote wheel by providing it with a steel sleeve race and roller-bearings and to the circular mhote, so popular in South Arcot, were under consideration.

5. Embankments and Channels.

Few things in Indian farming offer a better field for useful work by the departments of agriculture than permanent improvements to the land. This is especially the case in undulating country where a large percentage of the annual rainfall runs off the fields into the *nullahs* carrying with it much fertile soil. Both in the prevention and checking of erosion, in the carrying out of small irrigation projects and in economical distribution of water, a sur-

veying staff that can take levels and design simple works can render material assistance to the cultivators. In BOMBAY four Bunding Officers assist the public in this way. They prepare small projects with plans and estimates for individuals and groups of individuals and their services are in such demand that a large increase of staff could be very usefully employed. In 1929-30, in the Bijapur district, plans and estimates were prepared for 32 bunding schemes, costing Rs. 41,800, in 30 villages and for 14 reclamation schemes of small *nala* beds, costing Rs. 17,100. In Belgaum and Dharwar districts, 45 bunding schemes, dealing with 700 acres in seven villages, were prepared. A large joint scheme dealing with 313 acres at Tallur is under preparation. In the Deccan where there is only one bunding officer, 71 direct applications from the public and 34 through the Revenue Department were received. In Khandesh and Nasik, where this kind of service has only recently been organized, the bunding officer has dealt with 51 schemes. In 1930-31, projects were prepared for 35 schemes, located in 26 villages, estimated to cost Rs. 36,725. In the Belgaum and Dharwar districts, taken together, 22 projects, estimated to cost Rs. 16,700, were prepared; in the Khandesh and Nasik division, 36 projects and in the Deccan, 28 projects, while in the last named another 110 applications were on the books to be dealt with in the future. Similar work but on a smaller scale was undertaken in Bihar and Orissa, the United Provinces and the Punjab.

6. Agricultural Machinery.

Another activity that has occupied the attention of all agricultural departments is the development of cane-crushing machinery. With the spread of the new Coimbatore high-yielding canes in northern India, the limited capacity of the three-roller bullock mill is a serious handicap in those cane-growing areas where white sugar factories do not exist and this has caused the departments in the Punjab, United Provinces, Bihar and Orissa and Bengal to pay much attention to small power-driven sugarcane-crushing mills. Already several such mills are on the market and many of them are in use, but none is considered to be quite satisfactory. For experi-

ments in devising a satisfactory small power cane-crushing mill, the Imperial Council of Agricultural Research in 1930 made a grant of Rs. 8,000 to each of these four provinces. In the Deccan canal zone alone 81 mills of this kind were working during 1930-31 and that gives an indication of the demand that has sprung up. Progress has been made, too, in the design of many agricultural implements. In MADRAS, the Research Engineer was provided with a well-equipped workshop which should enable him to carry on his investigations unhampered by lack of space and equipment. As a result of his work the range of ploughs suitable for dry land conditions has been limited to two types, a light plough of the Meston type and a medium plough of the Monsoon Chattanooga or Punjab type. These are for ordinary conditions where the draught is limited to one pair of poor bullocks or one pair of reasonably good bullocks, respectively. With a view to aim at good quality of work and service, almost all ploughs in use at several of the agricultural stations are being fitted up with short beams and double-handles. Avery's Hindustan plough was subjected to a further trial in wet lands. The consensus of opinion was in its favour as the output of work is 30 per cent. more than that of the Meston plough, but its price being on the high side prevents cultivators from purchasing it in large numbers. An improved automatic seed-drill is under trial. Another item of work that has received considerable attention is the construction of an improved type of bullock yoke. A suitable design has been worked out, but like most other contrivances which are to be placed before the cultivator for his acceptance, it has to be made to a price before its greater mechanical efficiency will appeal. As its competitor is a log of wood, this is the more difficult part of the problem. Different types of hand-driven groundnut decorticators and chaff-cutters were tested. In BOMBAY a modified improved seed-drill was granted a patent by the Patent Office, Calcutta, in 1930 and was further improved. This drill is designed to sow any kind of seed to any depth up to six inches, for a seed-rate varying from 3 to 80 lbs. and for rows at varying distances apart. A new winnower, fitted with sieves to deal with *bajra*, *jowar*, rice and wheat, was put

through exhaustive trials with good results. Similar research was in progress on harrows, hoes, ploughs and a groundnut harvester, while a cotton-stalk extractor received special attention. A new material called Framotex Steel for the construction of implements was tested with promising results. A power chaff-cutter was demonstrated at five centres for preparing *jowar* for storing in silos. In BENGAL several models of improved iron ploughs suitable for ordinary cattle have also been produced by the Agricultural Engineer. Of these "Sobkam No. 2" seems certain to be widely used and the price, complete with hardwood frame, is only Rs. 5-8-0. This "Sobkam" is, therefore, much the cheapest iron plough on the market, and while it approaches the ordinary country plough in price, it can safely be said that it is not only two or three times as efficient, but that it will last at least twice as long. The "Sobkam" plough is now being used at all Government farms, but orders are also coming in from the public, a phenomenon hitherto without precedent in this province. Improved boiling-pans for *gur*-making were also under trial. In the PUNJAB work was carried out on the production of a suitable small winnower, baling press, and flame guns for the destruction of locusts. In BIHAR AND ORISSA the improved Bihar ploughs, cultivators and ridge ploughs have become popular; 1,384 were sold in 1929-30 and a somewhat smaller number next year. A modified Egyptian Norag, which is extensively used for threshing wheat in Egypt, was made and tried at Sabour with good results. In BURMA the Agricultural Engineer, who was appointed in April 1929, naturally spent some time in becoming familiar with the problems awaiting solution and has taken up the improvement of the seed-drill, winnower, an all-metal light water screw, detachable points for plough shares, and *gur* furnaces. In the CENTRAL PROVINCES, too, an Agricultural Engineer was appointed and has already successfully improved the Akola hoe and modified a groundnut decorticator so as to reduce breakage in shelling. At the INSTITUTE OF PLANT INDUSTRY, INDORE a new ridger for the interculture of cotton and other crops was evolved and already 529 have been sold. In MYSORE a smaller type of Mysore plough and a Kolar Mission plough have been made of

Bhadravati iron with the steel parts obtained from abroad, as no steel of the desired quality is now manufactured in India. A new seed-drill for *vagi* to regulate the seed-rate was under trial.

7. Mechanical cultivation.

The Burma Shell Oil Storage and Distributing Company of India, Ltd., has materially assisted the development of mechanical cultivation in India by undertaking experiments in conjunction with provincial departments of agriculture. At first they carried on ploughing demonstrations in Bengal, Madras, Sind and in several States, but afterwards concentrated their activities, so far as tractor ploughing was concerned, to a few areas and to definite problems in order to obtain data of value. At Mirpurkhas in Sind they ploughed about 600 acres on contract. While this work was in progress, the Bombay Government had decided to open six experimental farms in the Barrage area in Sind, that were to receive water in March 1932, and gave the ploughing to this company on contract. Different types of tractors were used and various implements. In the Dharwar district they also investigated the problem of the eradication of deep-growing weeds by deep ploughing with motor-tractors as opposed to the cable system. Here too several types of tractors, both kerosene and Diesel, were tried and mould-board and disc ploughs were used. Altogether 487 acres were ploughed. Considerable interest was aroused and many enquiries for work as well as enquiries regarding tractors were received. Reports were received of increased crop yields from various landlords whose land had been ploughed. The real test of the success of the work will be shown in a year or two, when it can be seen whether the grass (*Cynodon dactylon*) is growing again or not. At Raichur, too, in HYDERABAD STATE 1,425 acres of black cotton soil in weed-infested areas were ploughed to a depth of 10 inches. Full cost statements were kept to secure all the basal information necessary to provide for an accurate analysis according to the various circumstances met with. The Company proposes to continue this line of investigation as it is only by experience that the most economical way of running large ploughing projects can be discovered.

All their results were discussed at meetings of the Imperial Council of Agricultural Research. A tractor class was held with the help of the Company to give training to cultivators and college students in the handling of tractors and ploughs. A similar class for training in handling tractors, oil-engines and agricultural machinery was held in the Central Provinces. In the Punjab, Burma, Bihar and Orissa and Pusa work on tractors proceeded in the way of testing, and acquiring data of costs. The Fowler's steam ploughing tackle (double engine set) continued to be in great demand in the northern part of the Central Provinces and 927 acres were ploughed in 1929-30, but next year the area dropped to 690 acres due to the pinch of falling prices. In Pusa, too, the steam tackle was worked as before.

8. Electricity in Farming Operations.

At Cawnpore in the UNITED PROVINCES, experiments were conducted as to the relative cost of pumping, threshing and fodder-cutting. With a rate of 2·5 annas per unit for the first 900 units consumed per month and thereafter half that rate; preliminary experiments showed that the cost of the latter two operations was considerably less than it was when a kerosene engine was used. Now that seven districts in the United Provinces are covered by a "grid", the problem of usefully utilizing electric power in farm operations has arisen.

CHAPTER V

LIVE-STOCK.

1. Prevention and Treatment of Disease.

GENERAL REVIEW.

During the period under review the financial position deteriorated in India in sympathy with the rest of the world, with the result that the great expansion of provincial veterinary services which was recommended by the Royal Commission on Agriculture in India was impossible and in most provinces it was even found necessary to reduce the already strictly limited financial provision for such work. Reductions in staffs had accordingly to be made and the steady increase in the numbers of hospitals and dispensaries which is required for the gradual expansion of provincial veterinary departments could nowhere be undertaken. Similarly the strengthening of the research staff of the Imperial Institute of Veterinary Research, Muktesar, and at veterinary colleges, which is so urgently necessary, could not be carried out and in some instances the work in progress had to be closed down for want of funds.

Various measures were, however, taken to organize research work on a basis from which greater efficiency should result and expansion should be easier in the future.

For example, arrangements were completed for the separation of the work of the serum production station, located at Izatnagar where new buildings are now nearing completion, from the research work carried out at the Muktesar Research Institute itself and preliminary steps were taken to organize the staff of this Institute into sections each to deal with a definite class of work.

Moreover, with a view to organizing systematic field investigation of local disease conditions, in provinces and states, funds were granted by the Imperial Council of Agricultural Research for the employment of a specially trained veterinary investigation officer

in each major province and state affiliated to the Council. These workers should in time provide more precise information on the prevalence and control of a great variety of diseases the investigation of which has not hitherto been possible owing to lack of specially trained staff.

The number of cases treated during the period, in hospitals and dispensaries and on tour, showed a steady increase from 3,411,932 in 1928-29 to 3,841,266 in 1930-31, and there is evidence that this work is being more and more appreciated as it becomes better understood; while castration by the Burdizzo method is also increasing steadily throughout the country. This work is of great value as a measure of livestock improvement, but much more is still required to make the position satisfactory.

The recorded mortality due to rinderpest was high during 1929-30 but the incidence of contagious disease of all kinds showed an appreciable fall in 1930-31. Rinderpest was still the main cause of mortality but might have been less had not the control of this disease by inoculation been considerably handicapped in certain provinces, owing to their inability to purchase the quantities of serum required to deal effectively with the large numbers of outbreaks which occurred, as a result of a fresh wave of infection which passed over wide sections of the country during the year 1929-30. The endeavours which have been made during the past two years to cheapen the cost of serum production at the Izatnagar Station are however proving successful and should result in considerably reducing the price at which this product can be supplied in future.

Various methods of anti-rinderpest vaccination, which have been to a certain extent adopted in other countries, have been under investigation at the Muktesar Institute but the results so far obtained do not indicate that any one of these methods is likely to prove entirely satisfactory for dealing with the disease under the conditions which obtain in India. Observations at the Imperial Institute of Veterinary Research, Muktesar, and recently in the provinces, indicate however that a method of vaccination against this disease, with goat virus of reduced virulence, which has

been maintained at the Muktesar Institute since it was first fixed on goats by Dr. Edwards in 1926, may prove a cheap and satisfactory method of dealing with rinderpest in India, particularly among the highly immune cattle commonly met with in the plains. Very encouraging results have been obtained, both at Muktesar and in the provinces, from field inoculations carried out on plains cattle to test the practicability and safety of producing a lasting immunity in such cattle by vaccination with this virus and similar inoculations, with goat virus alone, on calves having a proportion of European blood and from immune dams, have been tested with satisfactory results. These preliminary tests, on plains cattle in different parts of India and on a certain number of calves of mixed European and Indian blood, indicate that this virus can be employed with safety for inoculation in such animals without the simultaneous administration of a protective dose of serum, and more extensive tests of this system of vaccination are now in progress.

Should this prove a satisfactory means of protection, generally applicable in the field, it would be of great economic value to India, both by reducing mortality and by doing away, to a large extent, with the necessity for the use of protective serum, the cost of which has in the past been a heavy drain on the severely limited funds available for such work in the provinces.

Under money grants made by the Imperial Council of Agricultural Research arrangements have been made for the employment of veterinary disease investigating officers for the major provinces and Indian States. This investigation staff, distributed over the whole of India and properly employed, should be of great value in assisting Directors of Veterinary Services to test new methods of disease control as they become available and to carry out the precise field investigation which is so urgently required regarding the many obscure causes of ill-health and degeneration of stock which occur in India.

Steps were also taken by the Imperial Council of Agricultural Research during the period under review to draft an all-India Act for the control of contagious disease, and provincial governments were approached with definite proposals for adopting measures to

improve the general standard of education and technical training at veterinary colleges throughout India. Such a raising of the standard of training of veterinary graduates has now become more than ever necessary in view of the fact that the duration of the curricula at veterinary colleges in other countries has recently been raised to a 5-year minimum course, it having been found that the very wide range of subjects which fully trained veterinary graduates now have to take, cannot be dealt with in less. Without courses of training of approximately equal duration it is obviously impossible to give the thorough training in pathology, bacteriology and scientific disease control which has now become a huge subject in itself and without a satisfactorily high standard of education it is impossible to take full advantage of such advances in scientific knowledge which are of practical importance to scientific animal husbandry.

The long duration and cost of such education and training must however entail a material raising of the standard of remuneration of provincial and other veterinary staffs, from the very low standard which now obtains, if a steady supply of such highly qualified officials is to be maintained. If better careers are not open to them than is at present the case, it cannot be expected that young men of a suitable standard of education will undertake such costly education and technical training, and if it is decided that increased numbers of fully trained men cannot be paid at a reasonable rate, steps should be taken to increase their capacity for carrying out work in the villages by providing a subordinate class of stock-men, specially selected and trained to perform inoculations, first-aid treatment, and minor operations in the field.

2. Disease control in the Provinces.

During the early part of the period under review there was a general recrudescence of rinderpest throughout the greater part of southern and central India. The incidence and mortality from this disease increased markedly during 1929-30 and though considerably reduced in 1930-31 the loss was still high. This heavy mortality was apparently to some extent attributable to the inability

previously mentioned of provinces to bear the expense of the large quantities of anti-rinderpest serum required to deal adequately with the wave of infection which passed over the country, particularly in 1929-30.

In the Punjab, North-West Frontier Province, Baluchistan and Burma mortality was mainly due to other diseases of which haemorrhagic septicaemia, black-quarter, anthrax and foot-and-mouth disease were the most important, haemorrhagic septicaemia being responsible for 46 per cent. of the total mortality in the Punjab in 1930-31. It was the main cause of mortality in that province, and the Director of Veterinary Services reports that this disease is increasing with the increase in water-logged areas produced by the extension of irrigation. The same remark applies to disease due to entozoal parasites and a proposal is now under consideration, by the Imperial Council of Agricultural Research, to finance a scheme for more intensive study of the causes and best methods of dealing with parasitic disease in such areas.

In Baluchistan liver-fluke is reported to have been responsible for 74 per cent. of the total recorded mortality, and it is clear that extensive local investigation is required, in this area also, to ascertain the best means of dealing with the problem under the conditions of live-stock maintenance which exist there, when suitable staff and facilities for such work are available.

In Burma sickness and mortality from rinderpest were considerably reduced, but foot-and-mouth disease was wide spread and caused a great deal of sickness and considerable mortality.

The treatment of surra in equines and camels, by the intravenous injections of suitable doses of Naganol, was carried out on a large scale, particularly in the Punjab, and this method of treatment is already proving a great boon to owners in areas subject to periodical flooding, where conditions are favourable to the propagation of the insect vectors of the disease.

3. Veterinary Research and Investigation.

IMPERIAL INSTITUTE OF VETERINARY RESEARCH, MUKTESAR, AND
THE IMPERIAL VETERINARY SERUM INSTITUTE, IZATNAGAR.

Rinderpest. Systematic testing of the various vaccines used in other countries was continued at the Imperial Institute of Veterinary Research, Muktesar, but the results so far have not been sufficiently encouraging so far as Indian conditions are concerned, to warrant the extensive employment of any of these methods of control in the field.

2. Attempts to develop a satisfactory potency test for anti-rinderpest serum have also not proved satisfactory but it is hoped that, as a result of investigations into the quantitative relations of the serum proteins, concentration of antibodies may be possible.

3. An important observation was made in the course of routine testing of anti-rinderpest serum, *viz.*, that in a case of rinderpest in a hill bull, which had died 74 days after inoculation with rinderpest virus, lesions of chronic rinderpest were found and the spleen proved to be infective on inoculation.

4. Other experimental observations showed that, even among highly susceptible hill bulls, rinderpest does not spread rapidly by ordinary contact with affected animals, however close, and that such animals are only infective for a few days following the initial access of fever.

These observations are important in regard to the practical application of control measures against this disease and are being published.

5. Work was continued on vaccines for the control of contagious equine abortion, haemorrhagic septicaemia and anthrax, and promising results were obtained from experiments undertaken with a view to improving the potency and safety of some of the vaccines hitherto employed.

6. Other work, on the presence of toxic metallic salts in sera, showed that enamel or shellac-lined vessels are the most useful for storing such substances over long periods.

7. Work was continued in the special John's disease herd, maintained at Muktesar for the investigation of this disease, and other investigations, carried out in the autumn of 1931, showed that a schistosome resembling *S. spindalis*, Montgomery, was present in specimens of tissues taken from all of the cases of bovine nasal granuloma available at the Muktesar Institute for examination. This work has since been confirmed in the laboratories of veterinary colleges in India and has been published.

8. Other investigations were made into a peculiar form of congenital blindness in calves, extensively met with in certain areas; upon the etiology of Bursatec; and on pasteurella recovered from animals suffering from a form of pneumonia.

9. Helminthological studies for the control of fluke disease, carried out in collaboration with the Director, Civil Veterinary Department, United Provinces, showed that the snail *Limnaea acuminata* was the intermediate host of *Fasciola gigantica*, which causes heavy mortality of cattle in the Kumaon hills, and that this snail could be successfully destroyed by the ordinary methods adopted for fluke control, while Danistol was highly efficient in removing these parasites from their animal hosts.

10. Other helminthological studies, upon parasites from cattle, elephants, goats and sheep, resulted in the discovery of a new round worm in a high percentage of cases of the goat pneumonia commonly met with in the hills.

11. The study of the disease due to *P. gibsoni* in dogs was continued, and observations were made on the transmission of *Anaplasma marginale* and on the treatment of these diseases with a number of the newer drugs now available.

12. The occurrence of a large piroplasm resembling *Babesia sergenti* in goats was recorded for the first time in India.

13. Malarial parasites (*Plasmodium bubalis*) were also found in the blood of buffaloes.

14. Work was continued on the prophylaxis of experimental surra in equines, and to perfect a serological test for this disease.

PUNJAB VETERINARY COLLEGE, LAHORE.

15. Observations were made, in the Physiological Section, on the safe doses to employ and the therapeutic effects of a number of new drugs, in the treatment of specific fevers and helminthiasis in dogs.

16. In the Hygiene Section an investigation, commenced in January 1930, into the milk supply of Lahore was completed and an exhaustive report submitted to the Board of Economic Enquiry, Punjab.

17. In the Anatomy Section work was continued in preparing notes and text-books on the anatomy of the ox, regarding which more intensive instruction was recommended by the Royal Commission on Agriculture in India.

18. In the Medicine Section observations were continued on the routine employment of urinary tests for confirmatory diagnosis in certain diseases, and on the etiology of peculiar local conditions met with in certain areas. Further progress was made in the investigation of indigenous plants employed in veterinary medicine and some were found to contain active principles likely to be of value.

BIHAR AND ORISSA VETERINARY COLLEGE, PATNA.

19. Observations on nasal granuloma, made at this College during the spring of 1932, confirmed the findings, previously made at Muktesar, of schistosomes and schistosome eggs in the nasal growths which are the main feature of this disease.

BENGAL.

20. In Bengal field experiments were undertaken in the use of the Muktesar fixed goat virus of reduced virulence, instead of bull virus, for the serum-simultaneous method of protection against rinderpest, and a number of young cattle of pure Indian blood were satisfactorily immunised by injections of this virus alone; in the course of a test of the safety of this method of vaccination for field work in the Province.

MADRAS VETERINARY COLLEGE LABORATORY.

21. *Pathological Section.* Laboratory experiments were undertaken for the study of the methods of infection and of immunization against anthrax and, as a result of further work on bovine lymphangitis, the organism associated with this disease was identified at the Lister Institute, London, as *B. pseudo-tuberculosis rodentium*.

Observations were also made on Pseudo-fowl pest and on the transmissibility of sarcomata and carcinomata in animals.

22. The production of rinderpest virus was continued and arrangements were made to test the feasibility of manufacturing anti-rinderpest serum in Madras throughout the year.

Work undertaken to test various vaccines used for the control of rinderpest in other countries had to be discontinued, however, because of an outbreak of foot-and-mouth disease among the experimental animals.

23. *Parasitological Section.* An extensive study was made of the seasonal incidence of cercariae in freshwater Mollusca, and new cercariae were found ; while the life-histories of *Paramphistomum cervi* and *Pischoederius elongatus* were worked out.

24. The finding at the Imperial Institute of Veterinary Research, Muktesar, of schistosomes in cases of nasal granuloma, previously mentioned, was also confirmed at this College, in the spring of 1932, and a number of fresh parasites were added to the museum collection.

25. Experimental observations were made on the transmission of surra and on other trypanosomes met with in Madras, and controlled tests were undertaken in the medicinal treatment of trypanosomiasis by means of Bayer 205 (Naganol), and of Theileria and other piroplasma infections with a variety of drugs.

26. In the Entomology Section a survey of the cattle ticks of the province was undertaken.

CENTRAL PROVINCES.

27. During the year valuable observations were carried out on a field-scale with highly encouraging results on the vaccination of

plains cattle against rinderpest by means of goat virus, originally obtained from the Imperial Institute of Veterinary Research, Muktesar. These observations confirm similar observations on a smaller scale carried out in other provinces, and give hope that the process may be of great value in field immunization against rinderpest in areas where the cattle are highly resistant to this disease, as is usually the case in the plains of India.

UNITED PROVINCES.

28. Observations on the fluke control, carried out in collaboration with the Muktesar Institute, have already been referred to.

CHAPTER VI

1. LIVE-STOCK BREEDING.

Cattle-Breeding.

In most provinces during the period under review difficulty has been experienced in carrying on the work already undertaken for the improvement of live-stock, and district boards, owing to financial stringency, were in many cases unable to take the bulls which had been specially bred for them on Government farms. Consequently Government farms have been financially embarrassed by having to maintain bulls beyond the normal period, since there is no demand for such bulls in the ordinary market, and this has become a serious matter both for the farms and for the steady progress which is essential in all live-stock breeding. It is obvious that, if the supply of improved bulls is not maintained, there is no option open to the breeders but to use such inferior animals as are available otherwise, and much of the advantage gained by the previous use of superior bulls is thus lost. Since most district boards receive grants from the Government for the improvement of stock and in some cases derive considerable revenues from cattle fairs, it seems clear that some arrangement should be made by which the bulls specially bred on Government farms for the use of district boards should be issued when ready for service in accordance with arrangements to be made by the provincial organization for the improvement of live-stock. Unless some system is put in force to ensure continuity, whenever financial stringency arises a severe check is likely to occur in the systematic improvement of live-stock which, to produce results of any significance, must be continuous through a number of generations.

The breeding of cattle for draught still continues to be the main interest of the ryots throughout the country, but interest in the improvement of cows for dairy purposes is increasing and the demand for suitable bulls of the milch breed in certain areas has been greater than could be met from the numbers available. This

is an encouraging feature because, in the absence of a local market for beef, the successful development of live-stock industry in India must depend very largely on the development of a dairy industry apart from that which already exists near the big cities.

According to a careful estimation recently made by the Imperial Council of Agricultural Research the cash value of the dairy products of India amounts, even in the present undeveloped state of the industry, to over Rs. 800 crores a year, and medical opinion is unanimous that, in the interests of the health and development of the people, the consumption of such products ought to be at least doubled.

This industry is therefore one of the most important individual industries of the whole world and one on the industrial development of which far greater expenditure of public funds would be warranted than at present.

Figures recently obtained from the Military Dairy authorities show moreover that, with proper breeding control and management, some of the best Indian breeds may be very rapidly graded up, by selection, in butter-fat and milk yield and that such improved pure Indian dairy cattle are the most economical producers of milk and butter-fat in India at present. Their results show that buffaloes are able to compete favourably with ordinary cows, and possibly with improved cows, only in areas where an abundance of coarse forage is available, but otherwise high grade cows of Indian milch breeds are already, after only a comparatively few years of selective breeding, able to hold their own, under suitable conditions of management, in regard to the over-all cost of milk and butter-fat production. Pure-bred Indian cows producing up to seven or eight thousand pounds of milk in a lactation, are to be found and this is recognised by practical dairymen in other countries to be as high an average yield as it is usually possible to maintain in commercial dairying, since the very high-yielding cow, owing to loss of constitution, increased susceptibility to disease, sterility and other factors, is not generally so suitable for the ordinary conditions of dairying. It seems, therefore, that with proper development there is no reason

why suitable pure-bred Indian milch cattle should not very soon be graded up, by selection, to compete favourably with imported and cross-bred cattle, taking into consideration the extra expense involved in the importation of bulls of European blood, and the difficulties which arise, in regard to increased susceptibility to disease and the disposal of cross-bred cattle, which in any case should not be retained for breeding purposes.

In the PUNJAB, work was continued to segregate out milking strains of two types from the existing herds, *viz.*, the white Haryana type and the grey Hissar type, and quite encouraging yields have been obtained in some of the best cows thus selected. This work is of importance since it is evident that good milking strains exist in both of these breeds and there is a definite shortage of the Haryana type in particular, as milch cattle owing to the constant drain on the best cows, which are sent to big cities such as Calcutta and Bombay and usually go to the butcher after completing one lactation. Consequently there is a definite danger that the best milk strains will eventually be lost unless adequate official steps are taken to encourage preservation of breed by systematic breeding of the best strains available.

One of the difficulties in carrying on work of this kind, at isolated farms such as Hissar for instance, is the difficulty of disposing of milk and dairy products at satisfactory prices, and this is a matter which local Governments should take up with a view to developing co-operative measures for collecting milk in rural areas, where there is no city demand, and disposing of it to the best advantage either as fresh milk, condensed milk or in some other form.

Work was continued on the grantee farms on the same lines as before and in one case, where a pure Sahiwal herd is maintained, valuable breeding bulls were made available free of cost for employment as stud bulls in suitable areas. On other grantee farms the results have not been generally satisfactory, but a scheme is now being developed to improve the class of cattle on small holders grants by supplying suitable bulls at Government expense for the service of selected cows.

In these operations, cows giving 2,000 lbs. of milk only in a lactation had at first to be accepted because better cows were not readily obtainable but already, with better feeding and care in mating, such low-yielding cows are being rapidly eliminated, and yields as high as 7,679 lbs. in a 300-day lactation have been recorded.

One-day village cattle shows, in which cash prizes are awarded to owners of selected cows, bulls, or young stock, are said to be a great success also, as breeding propaganda, in districts where it has been possible to take up such work.

In BIHAR AND ORISSA breeding work was continued at the cattle-breeding farm attached to the Patna Veterinary College on the same lines as before, but the lives-tock improvement work undertaken by the agricultural department has been much interfered with owing to financial stringency. Sahiwal cattle are said to develop satisfactorily in the province and as much as 7,000 lbs. of milk in a 360-day lactation has been secured, while the average yield of the cross-bred Thar-Parkar Desi herd maintained at the Patna Veterinary College has improved considerably during the period under review as the result of selection combined with scientific management.

The number of castrations carried out by the Veterinary Department during the period under review was greatly increased, but the number of stud bulls available for service is still much too small to have any appreciable effect. About 50 bulls have been distributed in North Bihar during the past 3 years and there were 56 stud bulls at veterinary hospitals in 1930-31. The total number of cattle in the province is however 21 millions and far greater numbers of improved bulls will be required before much effect can be produced.

Photographs of 2 typical Desi cows from this herd are shown in Plate II.

In MADRAS, pure herds of Ongole, Kangayam and Sindi cattle are still maintained, but the numbers are too small to have any adequate effect in the improvement of the 22 million cattle in the province, and cross-breeding was still in progress at certain



DESI COWS : PATNA CATTLE-BREEDING FARM.

Reproduced from the Annual Report of the Civil Veterinary Department, Bihar and Orissa, 1929-30.

farms though experience has shown that degeneration begins to show itself in the second and subsequent generations.

There were in all 82 approved premium bulls of which 50 were farm-bred. 25 stud bulls were maintained at district farms but the number of such bulls issued during recent years has shown a steady decline and it is stated that fewer indents for bulls are being received from district boards.

Funds for the development of dairying were not available but the premium bull scheme is said to work well and there were altogether 30 such bulls in the province.

Imported Sindhi cattle are said to do fairly well but it is difficult to maintain the progeny up to the original standard.

In BOMBAY there were 92 Government bulls at work in the province in 1930-31, an increase of 13 from the previous year, and an improvement is said to be noticeable among the cattle now being produced in the areas in which improved bulls are concentrated.

At the Northcote Cattle-breeding Farm, Chharodi, outbreaks of disease and the poor season were responsible for a check in the improvement of milk-yielding Kankrej cattle bred on the farm. Yields as high as 4,500 lbs. were obtained but no advance was observed in the development of early maturity, which is one of the objects aimed at.

In SIND the grading up by selection of Red Sindi cattle was continued at the Willingdon Cattle Farm and proposals are under consideration for establishing breeding farms for Bhagnari and Thar-Parkar cattle in tracts under perennial irrigation; but very extensive areas are available in the dry tracts in which hardy cattle can still be bred in large numbers and at low cost.

In ASSAM efforts are being made to improve the local breed and a certain number of Sindi and Thar-Parkar cattle which are not too big to mate with local cows are employed for breeding purposes. Disease due to parasitic infestation and other local causes is, however, a difficulty in this province which is not easy to overcome under the extraordinarily wet conditions which prevail during a great part of the year.

Other breeding.

SHEEP. The grading up of Bikaner sheep is being continued at the Hissar and certain other farms and results are very encouraging both in the improvement of type and in the staple of the wool produced.

The corss-bred Merino sheep which have been bred for some years at Hissar have now been made over to the Kangra Valley in the hope that they will withstand the climatic conditions of this more elevated area better than those of the plains.

HORSES AND DONKEYS. Horse and donkey breeding was also continued, particularly in certain areas in the Punjab and the United Provinces, and the successful measures which are now available for the treatment of Surra are likely to have a beneficial effect on horse-breeding, because breeders located in many of the most suitable areas could not afford in the past to keep good mares for breeding purposes, owing to their liability to die from this disease.

CAMELS. A certain amount of attention was also given to camel-breeding, particularly in the Ferozepore area of the Punjab, where the importance of the camel for work in connection with agriculture is said to be increasing.

POULTRY. More attention was given to poultry-breeding in most provinces and considerable success was obtained both in cross-breeding with European breeds and in the development of fixed types of cross-breds between such breeds and certain of the better defined Indian strains such as the Chittagong and Asil fowls, while Busra fowls have continued to prove particularly suitable for such cross-breeding. A certain amount of good work has also been done, particularly in the Punjab, in selecting and grading up suitable Indian birds by selection, but much more attention to poultry breeding and poultry diseases is required throughout India.

GOATS. During the period under review selective goat-breeding was continued at Hissar and one or two other farms and the progeny appeared to be very promising but difficulty was experienced at Hissar owing to a severe outbreak of contagious abortion.

Sanction was given by the Imperial Council of Agricultural Research for a grant to assist the Etah Mission Farm in grading up by selection two pure Indian breeds and to carry on a limited amount of cross-breeding with imported Toggenberg goats, a certain number of which were already available at the farm. The milk-yields of these goats will be carefully recorded and their pedigrees registered with a view to building up true breeding types of the two Indian breeds, and the results so far obtained are very encouraging. There is likely to be a considerable demand for such improved goats for breeding purposes in this area, which has in the past exported a number of such goats to other countries.

2. DAIRYING.

Work was carried on during the period under review at Bangalore, Wellington, Anand and Karnal on the same lines as previously, and it is gratifying to note that there was a considerable increase in the number of students under training for the Indian Dairy Diploma. This is most important work for the development of a scientifically conducted dairy industry in India and should be encouraged in every way possible. Twenty-seven students were trained during the year 1929-30 and 22 passed the final examination. Financial considerations however interfered considerably with the development of the industrial research into dairying practice which is so essential for the proper development of the industry.

Some investigations were carried out at the Anand Creamery regarding long distance transport of milk for city supply and regarding the manufacture of dairy products, but expert staff is required to enable this work to be dealt with satisfactorily and provision for this is now being made by a grant from the Imperial Council of Agricultural Research.

Special breeding work was continued at the Karnal Farm but it is clear that similar work, for the improvement of indigenous breeds of milch cattle, requires to be extended all over the country since results obtained during recent years in Military Dairies show that most striking improvement in such cattle can be obtained by

selective breeding and scientific dairy-herd management. For the practical benefit of the dairying industry throughout the country this is a much sounder line of development than any system of cross-breeding with European breeds, the benefit of which is likely to be only temporary and the harm resulting from indiscriminate cross-breeding incalculable.

The demands made on the office of the Imperial Dairy Expert for technical advice, from all parts of the country, showed no diminution, while most provincial governments and the larger Indian States made some effort to encourage the improvement of their milch cattle.

Co-operative Societies' Milk Unions made further progress in Dacca, Chittagong and Calcutta, under the guidance of the dairy section of the department of the Registrar of Co-operative Societies, Government of Bengal; and the Co-operative Department of the Government of Mysore completed a survey of milk-supply to Bangalore with a view to the erection of a modern co-operative milk factory in that city.

Experimental work was carried out under the Imperial Dairy Expert, in the manufacture of cheddar cheese by means of a purely vegetable coagulant; in the neutralisation of sour cream for butter making; in the pasteurisation of milk by various types of machines; on the percentage of the loss in milk pasteurisation and in the manufacture of ghee, rennet and lactic acid casein. Observations were also made on the percentage composition of milk yielded at different milking periods and the quality of milk obtained at different stages during the process of milking. Available records were also systematically studied with a view to determining average dry periods of various types of Indian cattle under varying conditions, post-graduate students being made use of in carrying out this work as a part of their course of training.

At the Anand Creamery work of a scientific nature was much hampered through the want of new machinery and buildings, particularly a milk-drying plant and a students' hostel, which are essential for the proper development of scientific research and instruction in modern dairy practice in India.

It is reported that during the period under review something like 50 per cent. of the herd at the Bangalore Dairy Farm were used for nutrition research and it may be pointed out that, though this is most valuable work in no way to be discouraged, it must necessarily have a very adverse effect on the results obtained from the milking herd.

The Central Bureau of Animal Husbandry continued to deal with large numbers of enquiries regarding cattle-breeding and dairying from breeders in and outside India and a number of pure Indian-bred cattle were supplied to breeders from the farm herds at Karnal, Bangalore and Wellington.

Propaganda work was continued by this Bureau and dairy films were supplied on loan to the Indian State Railways and to other institutions.

Short courses of practical training varying in length from 3 to 6 months were given at Bangalore, Wellington and Karnal and at the Anand Creamery, to 45 candidates from private organizations, Provincial Governments, and the Allahabad Agricultural Institute, while 4 British soldiers were given vocational training in dairying at the request of the Military authorities.

It is reported that, for the first time in the history of the institution, applicants for admission to the course of the Indian Dairy Diploma were far in excess of the number which could be taken with the limited hostel accommodation available. This is most encouraging as conclusive evidence of the popularity of the course, and instances are not wanting which show that students trained at this Institute are doing really good work in the country.

Mr. F. J. Warth, the Physiological Chemist to the Government of India, and his staff continued to work in close co-operation with the Imperial Dairy Expert and were of great assistance in the training of students and in the analysis of feeding stuffs used at the farms.

During the period under review a number of schemes for the opening of dairy farms by private individuals were examined and advice given by the Imperial Dairy Expert thereon, and it is significant that amongst the enquirers were a number of institutions,

such as *Pinjrapoles* and *Gowrakshas*, maintained for the benefit of abandoned cattle, which with the assistance of trained dairymen are now developing remunerative dairy businesses capable of doing much to save valuable milch cattle from the butcher and to improve indigenous breeds by the use of suitable sires.

In the course of the period under review advice was given to enquirers from practically all of the larger provinces and States throughout India and to applicants from a number of foreign countries and there is no doubt that work of this nature is very much required for the development of scientific dairying in India.

3. ANIMAL NUTRITION.

Work has been continued on the investigation of nutrition problems in different parts of India and two new sub-stations paid for the Imperial Council of Agricultural Research were sanctioned during the period under review, but the proper study of the nutrition of India's 300 million domesticated animals is a matter of huge economic importance and far more work of this nature is necessary throughout India in the interests of stock-owners of all kinds.

No change was made in the staff under the Physiological Chemist and large numbers of analyses were made of fodders, faeces, urine and soils, for the systematic examination of Indian fodders and in connection with feeding experiments.

Observations on the nutrition of growing animals showed that gram husk in certain circumstances could be used as a substitute for wheat bran, both of which brought about approximately equal increase in weight, and improved the consistency and palatability of the ration, though digestion experiments showed that gram husk has a distinctly lower starch equivalent value than wheat bran and contains no digestible protein whatever.

Calf-feeding experiments carried out at the Hosur Farm strikingly demonstrated the enhanced value of early-cut hay, the increase in live-weight in 100 days in calves fed on early-cut hay being more than twice as much as those fed on mature hay, the amount of concentrates consumed being equal. It was concluded that the

better productive power of early-cut hay was due partly to better consumption and partly to its high palatability. These experiments are of considerable practical importance as they indicate a line on which the nutrition of cattle in India might be much improved at little extra expense.

Other experiments carried out on growing heifers appeared to show that no greater advantage was obtained from a mixed ration, of 2 fodders, than was obtained from either of these 2 fodders fed alone, and further work on the feeding values of common oil-cakes has been published.

Arrangements were also made to carry out extensive observations on the rationing of dairy cows for milk production in collaboration, with the Assistant Controller of Southern Circle, Military Dairy Farms.

Feeding trials, to determine the relative merits of high and low silage feeding and the examination of typical hays were continued and the results so far obtained have been published. These trials indicate a very wide range of protein-content which was found to fluctuate between 18.0 per cent. and 1.9 per cent. and was attributed mainly to (a) characteristics of the species and (b) the stage of maturity. Graphic representation of the data thus collected revealed that the digestibility of all ingredients in the fodder is related to its protein-content and based on these results a graphic method was developed for estimating the nutritive values of fodders and is being published.

Observations on the effect of maturation on the nutritive value of hay showed that the amount of digestible protein and the starch-equivalent-values decreased steadily in all cases as maturity advanced.

With a view to going further into this matter, arrangements were made between the Physiological Chemist and officers of the Imperial and Provincial Departments of Agriculture to grow a number of pure species of pasture grasses, on selected sites in different parts of the country, representing the chief soils and climatic conditions met with. The work on protein digestion which had been in progress in previous years was completed and is being published.

A thorough examination was also carried out of *Jowar* cut at different stages of development and preserved under different conditions of packing, while other observations showed that no advantage was gained from ensiling *ragi* straw.

In the course of studies on diuresis it was found that certain animals always gave exceptional results and a scheme was organized to determine how far such anomalous urination affects metabolism.

Further work was carried out during the period under review on hippuric acid excretion, on the acid-base-balance of cattle urine, and on sulphur metabolism ; post-graduate instruction was given to four students, and a research student went through a course of training at the Institute.

A fresh proposal to establish an enlarged Nutrition Institute for all-India was taken up by the Imperial Council of Agricultural Research and a plan was prepared with a view to taking over the old X-Ray Institute at Dehra Dun for the purpose, but financial considerations prevented any further progress with this proposal.

CHAPTER VII.

VETERINARY EDUCATION.

During the period under review the new Veterinary College at Patna was completed and the first batch of students was admitted in July 1931 ; while the colleges at Lahore, Bombay, Madras and Calcutta continued their courses of veterinary training as before though, owing to financial stringency, a reduction of the course of training at the Lahore College from 4 to 3 years was under consideration.

Such a reduction would be a retrograde step, much to be regretted in the interests of veterinary education in India, and an endeavour was made by the Education, Health and Lands Department of Government of India and the Imperial Council of Agricultural Research, to carry out, as far as possible, the recommendations of the Royal Commission on Agriculture in India in this matter. The establishment of a superior college to train up to the M. R. C. V. S. standard was an essential part of those recommendations and the intention was to introduce new curricula, for the best course of training possible in a three-year course of instruction at all other veterinary colleges in India. It was, however, ascertained that there was little prospect of these measures being adopted in the near future, and the matter has been again referred to the Imperial Council of Agricultural Research by whom an alternative proposal was circulated to provincial governments, suggesting that the standard of veterinary training might be improved and made more uniform at small expense, if all the existing colleges would adopt the F.Sc. (Medical Group) Punjab or equivalent standard as the entrance qualification necessary for admission.

This proposal is now under further consideration and it is hoped that in the near future the revision of the present curricula will be undertaken by a committee of experts.

BOMBAY VETERINARY COLLEGE. There were 104 students on the rolls on the 1st of April 1929, and 130 on the 1st of April 1930. Of the former number 66 and of the latter 85 passed their examinations successfully. The number of students who passed their final

examination and left the college was 23 in 1929 and 19 in 1930 ; while 64 new students were admitted during 1929 and 50 during 1930. There were altogether 130 students on the rolls at the end of the year 1929-30 and 137 at the end of the year 1930-31. In the former year 8 new scholarships were awarded, seven to students belonging to the presidency proper and one to a scholar from Sind, making a total of 14 scholars in all. In the latter year 6 scholarships were awarded to students from the presidency proper and 5 to students from Sind, making a total of 14 scholars in all.

Of the graduates who passed in 1929, 13 are in the service of Government or local bodies, 9 are in the service of Indian States, and 2 are unemployed, while of the students who passed in 1930, 14 are in the service of Government or local bodies, 3 are in the service of Indian States and 2 are unemployed.

BENGAL VETERINARY COLLEGE. The demand for admission into the College from in and outside Bengal is stated to be increasing year by year.

At the beginning of the 1929 session 176 students were on the rolls, of which 163 continued their studies throughout the year, while at the beginning of the 1930 session 167 students were on the rolls, of which 141 completed the scholastic year.

The number of new students admitted into the College during 1929 and 1930 was 49 and 81 respectively. In consequence of the opening of a new Veterinary College at Patna in July 1930, the Government of Bihar and Orissa have withdrawn all their students from the Bengal College, but this factor did not affect the number of fresh admissions to this College seriously.

The number of students who held stipends was 112 in 1929-30 and 64 in 1930-31.

PUNJAB VETERINARY COLLEGE. Of the 122 candidates who offered themselves for admission to the College in September 1929, 61 were admitted, and of the 40 candidates who presented themselves for admission during September 1930, 36 were taken. As the standard of admission was raised to the Intermediate Standard in the Science or Arts Faculty, no Matriculates could be admitted and it is anticipated that there will not be much difficulty in obtaining F.Sc. (Medical Group) students in sufficient numbers in future.

The number of students at the end of the years 1929-30 and 1930-31 was 171 and 192, respectively.

The number of students who passed their final examination and left the college during 1929 was 38, and 42 during 1930.

Farriers' classes were continued during the period under review and 27 candidates passed in 1929 and 28 in 1930.

MADRAS VETERINARY COLLEGE.—In accordance with the recommendations of the Royal Commission on Agriculture and with a view to raising the standard of education, a revised curriculum has been introduced in this College with effect from the 1st July 1930.

The period of study under the new curriculum remains the same as hitherto, *viz.*, three years, but the curriculum is designed to provide a basic training in most of the essential subjects pertaining to veterinary science and the subjects have been redistributed among the 3-year classes. An important feature in the new curriculum is the prominence given to the study of cattle and the changes introduced into the subjects of comparative anatomy, the ox being taken as the standard instead of the horse.

The preliminary educational standard for admission to the College under the new curriculum is S. S. L. C. with 45 per cent of the marks in English, but in order to induce young men with higher educational qualifications to join the College, 14 of the 40 seats have been reserved for Intermediates and 6 for Science Graduates. On appointment to the department, three years' seniority for pay will be given in the case of Intermediates and five years' seniority in the case of Science Graduates. These men are not however given stipends as they will be started on a higher initial pay than the ordinary S. S. L. C. holder.

The number of students at the College has increased from 98 in the previous year to 109 on the 31st March 1930 and 117 on the 31st March 1931. Forty new students were admitted to the College in 1929 and 43 in 1930, the three students selected in excess of the usual 40 being admitted as extra non-stipendiaries, nineteen students passed the final examination in 1929 and 27 in 1930.

BIHAR AND ORISSA VETERINARY COLLEGE, PATNA. This College was started on the 1st of July 1930 and all the students from this

Province were transferred to Patna from the Bengal Veterinary College. The Patna College opened with 34 students, including 24 transferred from the Bengal College, Belgachia, and 18 more joined subsequently, making a total of 52 in all. The number on the roll at the end of the session was 49, of which 45 held stipends. Ten students passed the Diploma Examination from this College in 1930-31.

INSEIN VETERINARY SCHOOL. There were 13 students on the roll on the 1st April, 1929, all of whom passed the final examination and were given appointments in the department. During 1930-31, however, instruction was confined to Veterinary Assistants on Refresher Course, two such courses being held.

The re-opening of the College is held in abeyance pending decision of the Government on the reorganization of the department.

The numbers of students under training and who passed their final examinations during the period under review, at the different colleges in India, are shown in Appendix XI.

IMPERIAL INSTITUTE OF VETERINARY RESEARCH, MUKTESAR. It having been decided by the Government of India that an advanced post-graduate course for veterinary officers should be held only once in two years, no such course was held in the year 1929-30, but 9 officers attended the Institute at different times for short periods and were given practical instruction in all technical matters undertaken at the Institute.

During the year 1930-31 a post-graduate refresher course of 10 weeks' duration was held for officers of the Royal Army Veterinary Corps, Indian Veterinary Service and Superior Provincial Veterinary Services and four officers attended this course.

Later in the year sanction was given by the Government of India to throw open this course to officers of the ordinary provincial services and it was also decided that the course should be held annually in future if sufficient numbers of students were available.

Nine post-graduate students took practical courses at the Institute, of varying duration, and a research scholar from the Punjab joined the Institute for a 2 years' course of training.

CHAPTER VIII.

DISTRICT WORK.

This chapter deals with the greatest of all agricultural problems, to make new knowledge into common knowledge and to bring practice into conformity with that knowledge. The figures given in the preceding chapters illustrate the extent to which improved crops have been introduced and this one will deal with other improvements that are becoming part of the general agricultural practice of the country. Well-organised propaganda and extension work including arrangements for the supply of seed, implements and manures which in many countries is left to private agency are the means by which this object is being brought about. Indeed, the task of the agricultural departments in India is only half finished when research and field-experiments have proved the value of some new crop or method ; the improvement has still to be brought to the notice of thousands of small farmers, mainly illiterate and men of small resources, and the department must often act as seedsman or manure-seller at least until a supply organization can be built up such as is discussed in Chapter X. Progress in the introduction of new crops can be judged to some extent from the figures given in Chapter II showing that the ascertained area was over 13·4 million acres in 1930-31 as compared with 12 million acres in 1928-29. Progress in the introduction of improved implements is much more difficult to gauge, since the sales by and through the departments represent only a fraction of the total sales. Several firms are now actively engaged in implement manufacture, whilst many of the simpler implements are made, to an extent difficult to estimate, by small firms and individual artisans. To form any real estimate of the extent to which improved methods of cultivation have been taken up is still more difficult. During the early stages of the demonstration of such improvements some idea can be gained of the rate at which they are being adopted, but this stage is soon passed. Moreover, as demonstrating staffs gain the confidence of the cultivator their advice is taken on a variety of matters and the aid of the

department is sought in many directions. More important than the introduction of any single material improvement is the gradual and almost indefinable change in the outlook of the cultivator, and his recognition both of the existence of a department of Government which can assist him and of the fact that it is possible to raise the efficiency of his agriculture by the application of new methods. Such changes cannot be reduced to figures. That they are taking place is clear to many who in one capacity or another have been associated with the work of the agricultural departments and who have seen the scepticism of 25 years ago replaced by an active faith. For no province, much less for India as a whole, is it now possible to measure the agricultural standard of one year against that of its predecessor. All that can be done is to review the organisation and methods employed and to comment on new developments and on the relative effectiveness of different methods of bringing agricultural improvements to the villages.

1. Demonstrations.

Demonstrations on the cultivators' own lands under village conditions is the method of introducing agricultural improvements on which all agricultural departments still place most reliance. It brings the demonstrators into closest personal touch with the cultivators; they acquire a thorough knowledge of local conditions and so can give attention to details on which so much depends for the success of the demonstration. In MADRAS, the policy was adopted of concentrating the work of each demonstrator so that he could intensify his activities on four or five villages at a time, instead of covering a large area. Fewer items of propaganda were taken up and attention was paid to the more fundamental items such as clean cultivation, preservation of cattle manure, making of composts, care of cattle, use of pure seed and of improved implements and the preservation of land from erosion. In 1929-30, 6,200 demonstrations were carried out, a decrease of 860 from the previous year and in 1930-31 2,000 were made. The differences for the better were obvious in all cases but the profits were rendered less attractive by the fall in prices. In BOMBAY 1,468 demonstra-

tions were carried out in 1929-30 which is 301 more than in the previous year, and 1,610 in 1930-31. In addition a large amount of propaganda was carried on by the taluka development associations and co-operative societies, and the 124 past students of the Devihosur School working in their own land served as excellent propagandists. During both years, too, an effort was made at concentrated mass propaganda in the two districts of Ahmednagar and Sholapur. The two points demonstrated were the grading of *rabi jowar* and the adoption of methods of dry farming. The Collector, the revenue staff and the agricultural demonstrators all combined to bring about 6,000 cultivators into direct touch with the improvements. In Ahmednagar, 25 large meetings of cultivators were held in the first year and 40 in the second, while a total area of 430 acres were under demonstration in the one year and 650 acres in the other. It is said that the average increased yields were 19 per cent. for graded *jowar* and 65 per cent. due to dry farming methods.

In BENGAL 2,427 practical demonstrations were carried out in 1929-30 as compared with 2,613 in the previous year and 2,861 in 1930-31. In addition 140 private farms in the first year under review, raised to 165 in the second, served as effective demonstration centres. The District Magistrates everywhere, recognising the importance of this work, gave much practical encouragement which helped materially to its success. A good instance of such collaboration was the organisation of the collection of departmental seed from seed-farms and its distribution in Rajshahi to the cultivators of 20,000 acres whose rice crop had been badly attacked by *Sclerotium oryzae*.

In the UNITED PROVINCES, field demonstrations were mainly carried out on privately owned farms managed under the instructions of the departmental staff. This system, considered to be well adapted to the conditions of the province, has the advantage of enabling a number of demonstrations to be made at the same centre. Twenty-seven departmental farms in the first year and one more in the second were set apart for seed and demonstration purposes. The number of private farms increased from 961 in 1928-29 to 1,118

next year and to 1,240 in the succeeding year. The total area under village demonstrations including those of land rented for the purpose was 271,182 acres in 1928-29, 362,950 acres in 1929-30 and 373,204 acres in 1930-31. In the last year 324,130 acres were used for the demonstration of improved crops, 4,470 acres for green manuring and 44,604 acres for improved implements.

In the PUNJAB the number of demonstration plots laid out on cultivators' land was 1,521 in 1928-29, 2,316 next year and 2,336 in 1930-31. A majority of these plots, worked to show the advantage of improved cotton and wheat, were attended with success, the increased yields amounting to from 13 to 17 per cent above the ordinary yield of surrounding fields. The work started some years ago with the object of completely modernising agricultural methods in 293 villages was continued. In one of the Canal Colonies, a scheme was initiated to give a grant of half a rectangle, of 12.5 acres, rent-free for a period of three years, to tenants who farm their holdings best during the year, and 18 rectangles have already been awarded.

The total number of demonstrations in BURMA was 800 in 1928-29, 1,017 in 1929-30 and 1,182 in 1930-31. A special feature was introduced in the Myingyan Circle where instead of demonstrating particular items on isolated holdings, all operations of successful dry-farming were demonstrated on a few holdings. In the first year work was carried out on 18 holdings but next, year, with the help of a grant from the Indian Central Cotton Committee, demonstrations were carried out on 35 holdings involving the levelling and terracing of land, making bunds, adopting improved methods of cultivation with improved implements and using improved seed. So successful was this innovation that the yields of cotton *kapas* was from 100 to 150 *viss* instead of the district average yield of 75 *viss*. Such experiments are expected to have a very great influence on the surrounding cultivators by demonstrating that it is possible for cultivators themselves to better their own condition.

In BIHAR AND ORISSA the number of demonstrations was 6,060 in the first year under review and 8,061 in the second. In North

Bihar the "better farming campaign" was continued. Here the demonstrator equipped with a cart, a pair of bullocks and a set of improved implements simultaneously demonstrated the effects of improved cultivation, seed, implements and manures. Co-operative banks and other agencies also took a hand in this work employing 38 of their own trained demonstrators.

In the CENTRAL PROVINCES the number of demonstrations was 4,371 in 1929-30 and 4,200 next year. In addition, 54 demonstration plots were worked, 33 of which were worked by the department on rented land and 21 by cultivators on their own land under the immediate direction of the department. In ASSAM, the number of demonstration plots during 1929-30 was 1,583 as compared with 1,703 in the previous year but unfortunately half the number of plots in the Surma Valley were washed out by floods. In 1930-31 the number was 1,758. In SIND, the itinerant system of demonstration has also been found to be most useful. One-hundred-and-sixty-four villages were visited and 247 demonstrations given.

2. Peripatetic demonstrations.

In addition to the intensive method of demonstrating to the cultivator on his own land that he can make improvements on his agricultural practice, the possibilities of advertisement have been explored in several directions, *e.g.*, in using carts and motor-lorries to go round both demonstrating and exhibiting and in using fitted-up trains for exhibition. In the Punjab and in Bihar and Orissa, the carts were a special feature of demonstration that met with considerable success. In Madras and the Central Provinces the motor-lorry was being used while in Bengal and Assam demonstration trains were run. In the first method, the demonstrator, supplied with a cart, a pair of bullocks and a set of improved implements, goes round the villages when the land is being prepared or the crops sown and the success is so remarkable that not only do the cultivators sow the improved seed according to the improved method but they buy the improved implements. The two exhibition motor-vans, maintained by the Department of Agriculture in Madras, were a powerful means of attracting the attention of villagers wherever

they toured. They were specially equipped for every tour with a view to convey information on a few selected topics suitable to the particular district through which they passed and naturally the change of equipment had to be made very often. Next year a third motor-lorry was added to accommodate the demonstrator and his staff and thus give greater freedom in the choice of out-of-the-way places to visit. In the CENTRAL PROVINCES, the effectiveness of demonstration work was materially assisted by the cinema-lorry which was fitted out for each tour with the seed, implements and other things of interest suited to the tract in which it was to tour and was provided with a portable engine, which not only supplied the power to generate the current needed for the cinema projector, but at other times was used to operate a pump and fodder-cutter. Its interest-arousing ability was very great and its demonstrations were attended by hundreds of people at each place. The pictures may or may not be directly effective but there is no doubt that their attractive influence draws many a cultivator whom the demonstrator in ordinary touring would not reach and makes possible other effective demonstration work.

Demonstration trains were run for a short time but have now ceased owing to lack of available funds. There is some considerable diversity of opinion as to whether these trains are worth while, but the consensus of opinion appears to be that at present they are impracticable, partly owing to the length of each tour and partly to the difficulty of changes in languages, in staff and in agricultural methods advocated in different parts of the country.

3. Agricultural exhibitions.

In Madras the more important fairs, conferences and festivals held in each district were attended, exhibits shown and lantern lectures were given. The number of such exhibitions amounted to over 200 in 1929-30 and to about a 100 in 1930-31. In Bombay thirty-seven agricultural shows were held during 1929-30, the most important being the one organised by the Dhanu Taluka Development Association at Bordi, which was modelled on the method of the Presidency shows, the first of which was held in

Poona in 1926. The show was attended by 25,000 people. Just as many shows were held in 1930-31, the most important being the Nasik District Show which was organised by public subscription; the crop court was a special feature of this year's show, which was kept open for a week and was attended by some 40,000 people.

In BENGAL, the department subscribed during 1929-30 to 25 agricultural exhibitions, the more important of these being those held at Kalimpong, Suri, Manikanj and Jalpesh and as usual cattle-fairs and ploughing matches were held on these occasions. The number of exhibitions held during 1930-31 was less than in the previous year and the departmental contributions to them were cut down on account of retrenchment.

In the UNITED PROVINCES 91 shows were held in 1929-30, the most important being the one arranged on the occasion of the Kumbh Mela at Allahabad which was attended by several lakhs of people, but financial considerations restricted this form of activity in the following year.

In the PUNJAB all the fairs and large exhibitions in the province were attended by the district staff and the usual demonstrations were given. The agricultural stall, which was opened in the Lyallpur market in 1928, proved an excellent means of bringing the improvement of the department to the notice of the public and of establishing close contact with the commercial community. The amount of the sales and the number of visitors, 24,000 in 1929-30 and 15,000 in 1930-31, gave testimony to its popularity. All other provinces engaged in this form of activity to the extent to which funds and possibilities admitted.

4. Seed production and distribution.

In the chief rice-and cotton-growing tracts of MADRAS an extensive organisation for the supply of pure seed has been built up with the help of co-operative societies, private seedsmen and also seed-farms under the supervision of the department. The quantity of improved rice seed distributed amounted to 57,700 maunds in 1929-30 and 33,530 maunds in 1930-31. The area under seed-farms for cotton was 10,950 acres in 1929-30 and 10,920 acres in 1930-31.

In BOMBAY, seed-supply in 1929-30 was organised on an extensive scale for the cotton crop at three centres situated in the three important cotton-growing tracts. The most important development of the year was the substantial financial help given by the Indian Central Cotton Committee for this work. The best organised seed work was to be found in the southern division where the extension of the two departmental varieties, Jayawant and Gadag No. 1, was regulated at the successive stages from the small plot in the experimental farm to the ryots' fields, the initial stages being entirely handled by the department, and the last stages by the co-operative sale societies under the supervision of the department. The total amount of seed handled by the department and the co-operative sale societies of Hubli and Gadag amounted to 25,217 maunds. In Surat and Khandesh, the department distributed 31,013 maunds of 1027 A. L. F. and 328 maunds of N. R. and Banilla varieties. In SIND, 7,374 maunds of improved Deshi "No. 27 W. N." and 668 maunds of 4F American were distributed. As regards other crops, 9 maunds of wheat, mostly Pusa 12 in Sind, and 11,044 maunds of improved rice varieties were distributed to the ryots.

In 1930-31, the seed-extension schemes for Jayawant and Gadag No. 1 in Dharwar reached the next further stage and similar schemes were launched for the distribution of the Banilla cotton in Khandesh and 1027 A. L. F. in Gujarat. The Khandesh scheme, when it reaches its full development, will be the biggest cotton seed scheme so far organised in this province, and is intended to cover the whole cotton area in Khandesh with Banilla cotton. Seed operations with rice were mainly located in the Konkan and the system consisted in appointing ten registered seed-growers per taluka who were supplied with seed according to market rates on condition the department should be permitted to rogue the crop and the grower should make half of the produce available as seed. About 6,000 maunds of seed were distributed to the ryots in this manner. Similar work on a smaller scale was in progress for wheat, groundnuts, *bajri* and maize.

In BENGAL, there were 247 seed-farms aggregating 12,000 acres, from which 13,000 maunds of pure seed were distributed each year.

At Rajshahi, in particular, departmental seed was very much in demand owing to the shortage of local seed caused by the disease mentioned in Chapter III. Over ten lakhs of cane-cuttings of Co. 213 were distributed in each year.

In the UNITED PROVINCES, the number of private seed-farms was 1,118 in 1929-30 and 1,240 in 1930-31. The amount of seed distributed in the former year was 638,624 maunds and in the latter 1,059,840 maunds, about 80 per cent. of which was sugarcane and 16 per cent. wheat.

In the PUNJAB, the amount of improved cotton seed distributed was 30,455 maunds and 29,750 maunds, and of wheat 50,752 maunds and 37,200 maunds, in the two years. Great efforts were made to supply Coimbatore varieties of cane with the result that 80,000 acres were planted in 1929 and 104,400 acres in 1930. Cane setts were supplied free of transport charges to ryots on condition that the produce would be available for further propagation.

In BURMA 110 seed-farms were maintained in 1929-30 and 17 more were added next year, the aggregate area being 7,706 and 9,043 acres in the respective years. In the former year 86,980 maunds of pure seed were distributed and in the latter 117,600 maunds about 90 per cent. of which was departmental strains of rice.

In BIHAR AND ORISSA, the organisation of registered seed-growers, started in 1928, made some progress in 1929 but fell away in 1930 owing to the fall in prices. In 1929-30, 6,541 maunds of seed and 43,260 maunds of cane setts were distributed, while in 1930-31 the amounts fell to 5,715 maunds of seed and 11,366 maunds of cane setts.

In the CENTRAL PROVINCES, the total number of private seed-farms in 1929-30 was 14,273, an increase of 1,569 as compared to the previous year and again in 1930-31 there was a further increase of 1932. The amount of pure seed supplied in 1929 was 591,741 maunds of which 49 per cent. was wheat, 18 per cent. cotton and 22 per cent. rice and in 1930 showed a slight decline to 495,179 maunds, the decrease being due to the fall in the amount of wheat seed distributed which was only 31 per cent. of the total.

The chief feature of 1930-31 was the extensive roguing, collection, ginning and marketing of Verum 262 cotton carried out with the financial support of the Indian Central Cotton Committee. Seed amounting to 62,300 maunds was sold for seed purposes and 11,162 bales of cotton were sold at an average price of Rs. 212-8-0 per candy. These operations were conducted under the direction of the Deputy Director of Agriculture, Economics and Marketing.

In ASSAM from three seed-depots, fed by the produce from selected seed-farms, 3,671 maunds of rice, 2,431 maunds of potatoes and 164 maunds of jute seed were distributed in 1929-30. Helped financially by the Flood Relief Committee, the department distributed a large quantity of seed in the Surma Valley where the standing crops were destroyed by floods, and later on too in winter more seed was distributed in the stricken areas and this made *rabi* cultivation rather popular in the Surma Valley where it is not usually practised.

In MYSORE, a seed-supply organisation has been built up for the *ragi* crop. Sixteen private seed-farms were organised and the seed obtained from them was distributed for further multiplication on 'B' farms with the help of the co-operative societies. The further distribution of the seed from the 'B' farms has been carried out largely through the co-operation of village panchayats and co-operative societies. By these means seed sufficient for 16,000 acres was distributed among the ryots in 1930-31. The distribution of improved varieties of sugarcane and cotton was also organised on a fairly large scale.

5. Implements.

In Appendix V a statement of the agricultural instruments sold through departmental agency will be found. The sales of ploughs are characterised in all provinces by one satisfactory feature, viz., that sales of spare parts considerably exceed the sales of ploughs, a useful indication that the ploughs are used. The recorded sales are no real measure of the extent to which improved implements have come into use. Both manufacture and sale by private agencies is increasing and departmental sales in some cases represent little

more than the first following up of successful demonstrations. In all provinces the tendency is for the agricultural departments to devolve the supply of agricultural implements to other agencies as much as possible and to concentrate on experiment and demonstration. Co-operative organisations, however, have been disappointingly backward in taking up a branch of agricultural supply which can be run on a business footing and which is free from the risks accompanying the storing and supply of more perishable commodities. The total sale of agricultural implements through the agricultural departments amounted to 53,471 in 1929-30 and 49,998 in 1930-31 compared with 41,528 in 1928-29. The number of ploughs sold increased from 27,478 in 1928-29 to 30,396 in 1929-30 and fell to 25,513 in 1930-31, the largest increase being in the Punjab and Burma. The sales of fodder-cutters show a striking increase from 7,341 in 1928-29 to 14,510 in 1929-30 but decreased to 128,000 in 1930-31; the largest increase so far being in the Punjab where the number has nearly doubled. The number of cane mills also increased from 1,394 in 1928-29 to 3,302 in 1929-30 and 5,792 in 1930-31. The sale of spare parts increased from 29,848 in 1928-29 to 40,161 in 1929-30 and fell to 20,129 next year.

In MADRAS the sale of ploughs was entirely in the hands of private agencies and the Director notes that the sales have fallen considerably and that the requirements for spare parts have not been met; so the necessity for the department's shouldering the responsibility is becoming insistent. An excellent harrow, H. M. Guntaka, was thoroughly demonstrated throughout the presidency. In BENGAL, sales of the Sobkam plough, offered at Rs. 6, are increasing and for the first time the Bengal ryot is offered an iron plough at an attractive price. In the UNITED PROVINCES the Meston plough is in great demand and 8,887 were sold in the two years. The outstanding feature of sales in the PUNJAB is the large demand for Meston ploughs, cane-crushers and fodder-cutters. It is reported that there are about 21 iron foundries working at Batala with an output of 19,000 implements of all sorts. In BURMA the chief feature is the large number of Theikpan ploughs and shares sold, especially in the East Central and Myingyan Circles. It is

reported that private blacksmiths are casting the Theikpan plough shares and that one of them has produced a type specially suitable for sandy soils. In BIHAR satisfactory progress was made with the recently designed improved implements, the Bihar plough, cultivator and ridge plough. In the CENTRAL PROVINCES the striking progress made in the earlier years in the sale of implements has now received a check, the reason being that with a general fall in the value of agricultural produce, the cultivator is disinclined to make further capital expenditure. Special attention was, however, being paid by the district staff to seeing that the ploughs which have been sold were kept in working condition and not allowed to be idle. Reference to the more recent work on the design of improved implements has been made in another chapter and to propaganda in an earlier part of this chapter.

6. Fertilizers.

No complete returns are available of the sale of commercial fertilizers and oil-cakes, but the table in Appendix VI gives the ascertained sales by agricultural departments' depots. Sales by private agency too have always been important. Reference has already been made to the increasing use of green manures in certain tracts, whilst demonstration and propaganda for the better conservation and utilisation of cattle manure and other village refuse is steadily being carried on by the various agricultural departments as part of their regular programme. That the use of ammonium sulphate in particular steadily extended during the last few years, till, owing to the general economic depression, it received a check in the last year under review, is clear from the following figures :—

—	1926	1927	1928	1929	1930_
	Tons	Tons	Tons	Tons	Tons
Local production	14,555	13,451	15,082	16,121	16,189
Imports *	2,084	3,915	17,993	24,810	19,851
Exports *	4,304	3,750	10	0	4,850
Approximate consumption . .	12,935	13,610	33,065	40,940	31,190

* Figures for imports and exports refer to the financial year (April to March).

That the use of other artificial manures is extending may also be deduced from the following figures in tons for imports for the last five years :—

	1926	1927	1928	1929	1930
Nitrate of soda	6,070	7,458	8,840	11,722	4,329
Phosphatic manures . . .	12,591	18,670	25,743	30,807	27,327
Potassio manures	4,509	6,660	6,364	7,486	4,318
Ammonium phosphate types .	3,181	4,939	3,057	3,000	2,874

In 1930-31 there was a definite check in their use by the cultivator. The fall in the price of all agricultural products, especially of cereal products, which has accompanied world production in excess of effective demand, is removing the incentive to the use of purchased fertilizers which the earlier fall in the price of nitrogenous manures provided. Only in rare instances in India has the standard of production of any crop reached a point where a reduction in gross yield, in order to produce more cheaply, is warranted. But with the general fall in agricultural commodity prices, the cultivator's power to purchase fertilizers has been greatly reduced and other means of improving the efficiency of production are being sought.

CHAPTER IX

AGRICULTURAL EDUCATION.

On account of the general financial stringency, agricultural departments have not been able to develop the educational side of their activities, and with the stoppage of any further new recruitment in the departments, fewer students are interested in this branch of education.

1. Agricultural Colleges.

The continued financial trouble was again responsible for the set-back of the scheme for an agricultural institute at Dacca and the hope expressed in the last Review that it might be possible to start the engineering, dairying and animal husbandry sections of the institute was not realized. Nucleus sections of engineering as well as cattle-breeding and dairying were, however, started but the expenditure necessary to complete these sections was not available. Thus there are still few facilities for students who wish to take up agriculture in the eastern half of India.

The COIMBATORE AGRICULTURAL COLLEGE received 365 applications for admission in 1930 as against 303 in 1929. Out of this number the Committee selected 42 and 48 candidates in 1930 and 1929, respectively. Special lectures were delivered to second and third year classes by various research officers in the College. Forty-four students appeared for the B.Sc. (Agriculture) Degree Examination in 1929, and 33 passed, while in 1930, 24 out of 43 passed.

The POONA AGRICULTURAL COLLEGE admitted 82 students for the degree course in 1931 while in 1930 the number of students who received admission was ninety-seven. As in previous years a number of applications were received from outside the province and 10 such candidates were admitted each year. Last year the Bombay University conferred the Degree of B.Ag. on 53 students and this showed a fall of 8 from the previous year's figure. The staff was of the opinion that the candidates for admission to the

College are of too low academic qualifications and suggested some modifications in the degree curriculum of the University. A minor suggestion was made to Government to guarantee at least one provincial post for graduates with first class honours.

The AGRICULTURAL COLLEGE, CAWNPORE, was affiliated to the Agra University in 1930. This necessitated the immediate drawing up of proposals to meet the University requirements which included some additions to the existing staff, the raising of the status of the lecturing staff and important improvements in the material for instruction. A scheme embodying these proposals was framed and submitted to Government, who accepted some of the proposals but desired the curtailment of expenditure and further economy. In 1931 there were 175 students on the College roll as compared to 192 in 1930. Three-hundred-and-one applications were received for admission in 1930; of these 195 were for diploma course and 106 for the vernacular course. Forty-six students were admitted to the former and 23 to the latter course. In 1931 there were 151 applications for B.Sc. course, out of which 45 students were admitted. Admission to the vernacular course was stopped. The examination results in both the years were good; 32 out of 32 passed the Intermediate Examination in 1930 while in 1931 32 out of 36 passed the B.Sc. (Agric.) Examination.

The PUNJAB AGRICULTURAL COLLEGE, LYALLPUR, received 249 applications for admission in the year 1930 as against 412 in 1929. In 1931 the number was reduced to 102, mainly attributable to the fact that there were fewer posts in the Agricultural Department available for graduates than was the case a few years back. Seventy students in 1930 and 50 in 1931 were admitted into the College. Twenty-three students from the Khalsa College gained admission in the 3rd Year Class in 1930 but only 8 from that institution joined in the next year. The University results during two years under review were fairly good, for 34 out of 52 in 1930 and 40 out of 69 in 1931 passed the degree examination. The total number of scholarships for the students of the College were 115 during 1931, out of which 40 were Government scholarships and the remaining 75 were generously donated by District Boards

and private bodies in the province. Two out of three students passed the M.Sc. (Ag.) in 1931.

The NAGPUR AGRICULTURAL COLLEGE, which was affiliated to the Nagpur University in 1925 and held its first degree examination in 1929 in which 5 out of 13 candidates were declared successful, showed much better result in 1930 when out of 19 students 18 passed. The comparatively poor academic results in the past were attributed to the fact that a large percentage of students recruited from the farming communities were not sufficiently educated to be able to cope with the requirement of the degree course. This difficulty was met by stiffening the first year examination and by the introduction of qualifying examinations in the course of the second year, in order to eliminate the unfit students. During the year 1930-31, the 8 students who completed the requirements were allowed to sit in the final examination in which all passed. With the intention of equalizing the numbers in various classes in 1931-32 and not causing the lack of room in the hostel in that year to react against the admittance of a satisfactory number of students, the Principal restricted the number of first year's admissions.

The MANDALAY AGRICULTURAL COLLEGE had 40 students on the roll in 1930-31 as compared to 47 in the previous year. The total number of applications for new entry was 78 in 1930, out of which the Board selected 20 stipendiary and 4 non-stipendiary students. A private Japanese student was also admitted. In the final diploma examination held in March 1930 all the 8 students came out successful, and in the 1931 examination 8 passed out of 9.

The HEBBAL AGRICULTURAL SCHOOL, MYSORE, continued to show an increasing popularity, and the total number of students on the roll increased from 45 in 1928-29 to 71 in 1929-30, and 72 in 1930-31. The school received 158 applications for admission in June 1931 as against 102 in 1930. Two new blocks for accommodating the students in the hostels were built and to allow more adequate practical training a large number of microscopes and 5 new pairs of bullocks were purchased. Of the 24

students who sat for the final examination 12 passed in 1930, of whom 4 passed with distinction. In addition to the regular work of the school, the staff conducted special training classes for Revenue Probationers and Inspectors and these were attended by 24 candidates.

2. Post-Graduate Training in Agriculture.

The IMPERIAL INSTITUTE OF AGRICULTURAL RESEARCH, PUSA and the IMPERIAL INSTITUTE OF ANIMAL HUSBANDRY AND DAIRYING, BANGALORE, continued to offer facilities for post-graduate training in various branches of agriculture. At Pusa three students, one in botany, one in chemistry and one in entomology, completed the two years' post-graduate work in 1930. In the same year, the Entomological Assistant from the Central Provinces and the Assistant Professor of Agriculture in the Punjab Agricultural College completed their one year's training in entomology and botany, respectively. Of the 37 candidates for admission to new session commencing 1st November 1929, six were considered suitable by the selection committee, and accordingly two were admitted for training in mycology, three in botany and one in entomology. An agricultural assistant from the Punjab and a Probationary Assistant Director of Agriculture, Bihar, were admitted to special one-year courses in sugarcane cultivation and general agriculture, respectively. In the same year 4 post-graduate students completed their 15 months' course in animal husbandry and dairying at Bangalore and an equal number was admitted for the new session. In 1930-31, five post-graduate workers completed their two years' work at Pusa, 3 in botany and one each in mycology and chemistry. Thirty new applications were entertained for the session beginning November 1930; seven were selected for interview, of whom two were admitted, one in botany and one in mycology. Two other students were accepted for training in botany, and one from Indore Durbar for training in chemistry. One provincial assistant and one deputed by the Jaipur Durbar joined the practical agriculture course. In the same year 5 post-graduate workers completed the 15 months' course in dairying

and 3 joined for the next session. The two-year course for the Indian Dairy Diploma was completed by 24 students.

3. Agricultural Schools.

Besides the two-year course given at several agricultural colleges, there is still a need felt for some sort of vocational agricultural education in various parts of the country and the Governments concerned are doing their utmost to meet the demand. The Taliparamba Agricultural Middle School in MADRAS, which was opened in 1922 for the purpose of providing a Vernacular course of instruction in the principles of agriculture with the intention of sending the boys back to the land as better cultivators, did not function as satisfactorily as it used to during the early years of its existence. In 1929-30 there were 14 boys in the second year class and out of the 17 admitted in the first year only 9 continued to attend till the end of the year. The total strength of the school in the following year was only 12 out of which 8 were in the second year and 4 in the first year class. Such a state of affairs was attributed to the fact that the farmers consider two years to be too long for their boys to be away from their parents who need their presence during the busy agricultural season. The new school at Usilampatti opened in 1929 continued to be under the management of the District Board of Madura. The Agricultural Department lent two officers for teaching and the Government gave a half grant for its maintenance. Even here the attendance was not encouraging; there were 13 students in the second year while out of 5 admitted in the first year 3 left in the course of the year. The 3 farm labourer schools, however, continued with a fair measure of success. There were in all 61 day and 48 night students in 1930-31 as against 57 day and 47 night students in the previous year.

Out of the six agricultural schools in BOMBAY, 3 came under the retrenchment axe and were closed in 1930. Of the rest, the Agricultural School at Devihosur is the most popular and has done a good deal of useful work. In 1930-31 out of 127 applicants for admission 60 boys were allowed to appear at the entrance examination and 23 were selected for admission. In the same year

12 out of 13 boys passed the two years' course. 124 passed students of this school are working on their own farms.

The Bulandshahr Agricultural School in the UNITED PROVINCES played a most useful part in the training of teachers of the Vernacular Middle Schools. There were 31 such teachers in 1931 as compared to 43 in 1930 who received training in subjects such as agriculture, co-operation, hygiene, irrigation, and civics. In the two-year regular course 31 out of 33 students passed the final examination in 1930 while 29 out of 33 got through in 1931. The newly started school at Gorakhpur gained in popularity, and a large percentage of candidates for admission to the school consisted of those who owned sufficient landed property and proposed to take up farming as their profession. An Agricultural and Village Uplift Institute for training the sons of zemindars and cultivators was started in June 1931.

In the CENTRAL PROVINCES, the Powarkhera Agricultural Anglo-Vernacular Middle School, which is the only one of its kind in the province, continued to be popular amongst the cultivators. The total number of students in all the four classes was 110 in 1930 and 115 in 1931. The final class results in both the years under review was very satisfactory: 15 out of 16 passed in 1930 and 13 out of 17 were declared successful in 1931. The prescribed syllabus was followed and the instruction imparted was of a higher standard. The boys took a keen interest in the practical work on the farm and garden which covers an area of $6\frac{1}{2}$ acres. During 1929-30 the gross return of all crops on the farm was Rs. 259 of which vegetables contributed Rs. 173. The year 1930-31 was not particularly favourable but the students were able to produce a fair amount of vegetables for consumption in mess. In addition to the school the Agriculture Department was running two agricultural classes of pre-vocational character at Yeotmal and Buldana. The former has been in existence some two or three years but is not very popular. The latter which was started in 1929 had 14 boys in the first year out of which 12 qualified for promotion to the second year. In the year 1930-31 political activities inter

ferred with its regular working and the school remained closed for 3 months.

The Pysinmana Agricultural School in BURMA is financed partly by the American Baptist Mission which is also the controlling body and partly by Government. The object of the School is to train persons coming from the village communities so that they may take up farming as their business and successfully practise it under local conditions. Since the opening of the school in 1923, one-hundred-and-twenty-one students have gained the lower middle certificate by passing the two years' course, and 54 were graduated after completing 4 years. Of the former students 49 are engaged in agriculture proper, 10 in gardening, 14 are school teachers and 8 are in the Agriculture Department. The two farm schools at Hmawbi and Mahlaing worked successfully. The courses given at Hmawbi comprised instruction in determining the different kinds of paddy and rice, the characters of good quality of paddy, the principles of manuring and instruction in horticulture.

Three vernacular schools in MYSORE continued to do useful work and gained in popularity. The respective district boards in which these schools are situated displayed a very marked practical interest and gave special grants to the schools. All these schools were well equipped in the form of land, bullocks and implements for practical instruction and the attempt was being made to bring the teaching to a uniform standard. The three agricultural schools in TRAVANCORE, for imparting instruction in the elements of practical farming to boys who intend to follow agriculture in after-life, did useful work. Twenty-one students were admitted in Alwaye School, out of whom 16 received a stipend of five rupees each per month. They were also allowed to work for wages on the farm attached to the school outside class hours. Kottarakara school had 29 students in training in 1930, out of which 20 received a stipend of Rs. 4 each. At Koni School 52 boys were in attendance of whom 30 were getting a stipend of Rs. 4 each.

4. Rural 'Bias' Schools.

The demand for rural 'bias' schools is being met by opening agricultural classes in various anglo-vernacular schools in different

provinces. In the Punjab, the United Provinces, Bengal and Bombay arrangements are also made to train teachers for teaching this subject in the schools. In BENGAL the first batch of 15 secondary school teachers under training, in connection with the scheme to introduce agricultural classes into secondary schools, completed their two years' course at Dacca School in December 1929. Out of the 15 schools, to which these teachers went back, nine were reported to be doing satisfactory work in 1930-31. The other six were carefully watched and it was decided that in case they do not improve, their grants would be withdrawn. In 1929-30 an officer of the Bengal Agricultural Service was appointed as Inspector of Agricultural Schools who collaborated with the school authorities in the preliminary work of organizing classes, purchasing apparatus and reclaiming and levelling land to be used for practical work. In BOMBAY there were 84 agricultural 'bias' schools in 1929-30 and 81 next year. The training of teachers for these schools was considered to be an important matter in the agricultural 'bias' educational movement and the need was felt of improving the Rural Training School at Narayangaon for training such teachers. A need was also felt for opening another training school in Kanarese Division where the agriculture 'bias' movement was gaining ground. In the UNITED PROVINCES, the agricultural class with small demonstration farms opened at four schools in the Eastern circle and two in the Central Circle were doing useful work. New agricultural classes were opened in 8 more schools in the Central Circle. The Agricultural Department maintained a close touch with these schools and assisted them in preparing cropping schemes and supplied improved seeds and implements. In the PUNJAB there were 143 vernacular middle schools in 1930 where courses in elementary agriculture and nature study were imparted to the students and the number increased to 150 in 1931. Each school is equipped either with a small farm or a school garden, which is run by the Education Department with advice from the Agriculture Department, which in addition provides a one-year vernacular course at the Agricultural College, Lyallpur, for the training of teachers. Twenty-seven senior vernacular certificated

teachers took this course in 1930 and 25 of them were declared successful in the final examination. In 1931 there were 25 students in this class.

5. Short Courses.

During the two years under review short courses in special subjects given at various agricultural institutions and demonstration farms became more popular and the number of those attending increased as compared with the previous years. In the PUNJAB the two vernacular classes of 6 months' duration each were attended by 84 and 32 students, respectively, in 1930 and 39 and 32 students in 1931. The six weeks' blacksmith course for training in the running and maintenance of internal combustion engines and in the maintenance of modern agricultural implements was attended by 13 mechanics in 1930 and by 14 such men in 1931. The two weeks' courses in fruit culture and fruit and vegetable preservation were given twice each year—in July and February of 1929-30 and 1930-31. These courses were extremely popular and only a comparatively small proportion of those applying for admission to them could be accommodated. The rural economy class of one month duration was attended by 23 officers in 1930 and by the same number in 1931.

The two short courses in practical agriculture started at Nagina and Shahjahanpur in 1928 in the UNITED PROVINCES continued to work satisfactorily. All excepting two students of the first batch have started on their own farms. In 1930, four students of Nagina farm were given a grant-in-aid of Rs. 300 each, on condition that they supply to the Department 40 maunds of wheat seed at market rates every year for 5 years. The Shahjahanpur farm class did not admit any student in 1931, while at Nagina, out of thirteen students on the roll, there remained only four who appeared in the final examination. A short course of instruction in sugarcane cultivation of 10 days' duration was started in 1929 at Shahjahanpur farm for officers of the Irrigation Department nominated by the Government.

In BOMBAY classes were organized for training in irrigated crops, horticulture and land improvement. The class on irrigated crops was attended by cultivators as well as the subordinate staff of the Irrigation Department. A horticulture class organized at Akola was attended by 36 students and another at Jambul was attended by 53 cultivators. A short tractor class of two-and-a-half months' duration was opened to train students in the management of different tractors. For the course Messrs. Volkart Bros. supplied four tractors of different make and Messrs. Burma-Shell Oil Storage and Distributing Company were kind enough to find all the oil and fuel. Seventeen students joined the class but only 9 appeared in the examination of whom 7 passed.

In BURMA short courses of a few weeks' duration were held at various times of the year on the experimental farms for adult cultivators who cannot afford to be away from their holdings for longer periods. The cultivators who came to these farms were brought into personal touch with the work on the farms and friendly relations were established between them and the staff. A short course in plant-breeding and experimental plot technique organized for provincial and senior agricultural assistants in 1929-30 was attended by 10 members of the district staff.

In the CENTRAL PROVINCES a nine months' class for training teachers to give instruction in elementary agriculture, on the lines followed in some of the Vernacular and Anglo-Vernacular Middle Schools in the Punjab, was opened in 1931 with a roll of eleven. It was thought that these men would be useful in rural "bias" schools which the Department will start when funds permit.

6. Adult Education.

Facilities were provided for adult education in several provinces. In the Eastern and Central Circles of the UNITED PROVINCES there were 40 co-operative adult education societies in 1929-30, and this number increased to 47 in 1930-31. The societies in Benares district got their teachers trained in the rural workers' training class opened at Benares, and those at Partabgarh were

provided with village guides trained at Partabgarh. Several meetings were held and various subjects connected with agricultural improvements were discussed. Lectures were delivered on proper methods of preservation of farmyard manure, advantages of improved seeds, deep ploughing, labour-saving machines and implements, artificial manures, and advantages of green-manuring and other agricultural subjects.

CHAPTER X

THE CO-OPERATIVE MOVEMENT AS AFFECTING AGRICULTURE.

The co-operative movement, which started about 25 years ago, progressed remarkably within this short period and the number of societies in the whole country increased from 1,500 in 1908-09 to 104,187 in 1929-30. The majority of these are concerned with one or the other phase of agriculture, especially with the credit movement amongst the cultivators. The total number of agricultural societies in 1929-30 and 1930-31 was 77,550 and 78,633, respectively, out of which 74,145 and 73,600 were purely for credit purposes. Though the previous yearly rate of increase as regards the number of societies and their membership figures have not been maintained during the two years under review, still the movement shows an all-round improvement with few weak spots here and there. The major cause of slowing down the rate of progress is the decline of prices of agricultural commodities and the disturbed credit facilities throughout the world to an extent almost without precedent. In spite of the policy of caution, which has been adopted in all provinces, the amount of outstanding dues has considerably increased. The rapidity of the movement in previous years brought into existence some weak societies with unscrupulous members, with the result that a few influential members monopolised the bulk of the loans and proved to be the worst defaulters. Lack of understanding of the principles of co-operation was another cause of bringing certain societies to grief. To check the further spread of these evils and to eradicate or at any rate to eliminate the existing weaknesses, the co-operative departments directed their energies towards the consolidation of the movement and the spread of sound ideas.

On the other hand, the new policy adopted by the provincial governments has elevated the general trend of the movement. In Bombay new registration is confined only to societies with share

capital and the old societies have also been advised to adopt this system. Bengal has suggested the discontinuance of the defective policy of investing short-term capital in long-term loan. By establishing a Central Land Mortgage Bank, Madras has given a great impetus to the primary mortgage banks. The general policy adopted by all provinces of confining the movement to productive channels and weeding out bad societies has met the need in the present depression.

The development of the agricultural non-credit societies, in particular, has been very rapid during these years, and the range of their function has been greatly widened. They include societies for the general sale of agricultural produce, for production and sale of implements and manures, for furtherance of irrigation projects, for consolidation of holdings, for maintenance of construction of roads and for assisting agricultural departments in spreading knowledge of improved methods of cultivation.

Madras.—From 12,947 in 1928-29 the number of agricultural societies of all types increased by 19, bringing the total to 12,967 in 1930-31. These societies distributed Rs. 163·5 lakhs to their members as loans of which about 99 per cent. was for productive purposes. Another noticeable feature was the preponderance of loans for short-term purposes; the ratio between the short-term and the long-term being 62 : 38.

The number of agricultural credit societies increased from 12,382 in 1928-29 to 12,540 in the next year but fell to 12,310 in the succeeding year. The membership figures, however, showed a continuous increase and now stand at 676 thousand. The total divisible profit earned by the credit societies in 1929-30 and 1930-31 was Rs. 11·5 and Rs. 8·05 lakhs, respectively.

The Government sanctioned a scheme for the establishment of a Central Land Mortgage Bank composing of individual non-borrowing members and primary land mortgage banks affiliated to it. The bank was registered in December 1929 and was empowered to issue interest-bearing debentures on the security of mortgages executed in favour of primary banks. For the safeguard of the investor government undertook to guarantee the interest not ex-

ceeding 6 per cent. for a period of 20 years on all debentures issued within the first 5 years up to a limit of 50 lakhs of rupees. The unsettled condition of the money market, however, affected the operation of the bank which experienced considerable difficulty in selling its debentures. As there was no prospect of a steady flow of funds, the organization of new banks was suspended and postponed till the financial conditions improve. On 1st June, 1931, the bank had 166 individuals and 37 primary land mortgage banks as members; its paid-up share capital amounted to Rs. 99.5 thousand. Government help to the bank has been in the form of a free grant of Rs. 14,000 to meet the working expenses and a loan of Rs. 15,000 for establishment charges. It has also remitted the duty charged under the Indian Stamp Act on deeds of transfer in respect of the debentures of the bank. Last year the bank issued debentures for Rs. 10 lakhs, bearing interest of $6\frac{1}{2}$ per cent. per annum. The 37 primary land mortgage banks had 5,128 members with a working capital of Rs. 17 lakhs. Fifteen of these banks worked at a profit of Rs. 18,372, and the remaining 22 incurred a loss of Rs. 11 thousand.

Out of 128 PURCHASE AND SALE SOCIETIES in the beginning of the year 1931, there only remained 108 at the end of the year. Sixty-six of them were loan and sale societies which, in spite of a constant effort, did not develop as they were expected and thus some of them had to be liquidated. At the beginning of the last year under review these societies had a stock of goods worth Rs. 39 thousand and during the year they purchased goods to the value of Rs. 456 thousand, and out of this, stock worth Rs. 465 thousand was sold to the members. The 13 irrigation societies undertook the work of silt digging of irrigation channels. Water was supplied to irrigate 2,261 acres of land, the cost of which was paid by the members. These societies also brought 2,943 acres of new land under cultivation.

The LAND RECLAMATION SOCIETIES, which increased from 10 to 12 in the two years, did fairly good work and reclaimed 1,664 acres of silted land. The number of agricultural demonstration societies, however, remained constant but out of the total 17 only 3 can be

said to have done useful work. These 3 societies cultivated 83 acres of paddy out of which 73 acres were under improved methods of cultivation and the rest were under ordinary methods generally used by the farmers. The net gain per acre between the old and the improved methods ranged up to Rs. 27 in 1929-30. These societies have also undertaken the work of supplying improved seeds, manures, etc., to their members as well as to non-members, and in the last year they did business worth Rs. 45 thousand with the members and more than a lakh with non-members.

Bombay.—The process of consolidation and elimination of weak co-operative societies was continued during the last two years and as a result of this vigorous step a large number of bad societies and improvident members have been eliminated. The policy has already begun to show its results in a better standard of management, and the figures show an all-round progress. The number of agricultural societies rose from 4,568 in 1928-29 to 4,889 in 1930-31; similarly membership increased from 338 to 339 thousand, working capital from Rs. 369 to 449 lakhs and reserve fund from Rs. 50 lakhs to Rs. 66 lakhs.

AGRICULTURAL CREDIT SOCIETIES.—The progress in this particular field of agricultural co-operation has been satisfactory. The number of these societies increased from 4,317 to 4,650, membership increased by 5,715 and the working capital by Rs. 75 lakhs, in two years ending with 1930-31. In the same period the reserve fund showed an increment of about Rs. 15 lakhs. There was, however, a fall of about 3 lakhs in the members' deposits. This was partly due to the recent policy of confining new registration to societies with share capital and advising the old societies to adopt the share system bye-law, and partly to the adverse economic conditions which forced the agriculturists to draw upon this source of their savings, for meeting household and agricultural needs.

The standard of efficiency in the working of societies is gradually rising and this is mainly due to the activity of supervising unions. The accounts are generally kept up-to-date and there are now fewer chances of mismanagement due to ignorance of rules and bye-laws.

The condition of 3 CANAL SOCIETIES is serious. The reason is that the old loans are overdue and these have been further added by fresh loans in the hope that the conditions would improve and that the sugarcane growing would become a paying proposition. This has not come true and the price of *gur* and other cash crops like cotton and ground-nut having fallen all-round, all the growers have lost considerably. Three LAND MORTGAGE BANKS, on the other hand, have done good business, but could not proceed with their programme on account of the lack of funds. The application sanctioned for advancement on loan exceeded the money which could be lent and the position at present is that Rs. 3.61 lakhs are immediately needed for meeting the sanctioned and the pending loan applications.

AGRICULTURAL NON-CREDIT SOCIETIES.—On the whole the working of the existing societies was quite satisfactory but no further development occurred due to inability to secure efficient personnel for management.

Societies for the sale of agricultural produce, especially cotton, constitute the most important of agricultural non-credit societies. During 1930-31 these handled 4,00,243 maunds of cotton and realised Rs. 37 lakhs. There is, however, a great danger to which sale societies are particularly prone at the moment, *viz.*, that the buyers, due to the existing trade depression, are not meeting their obligations. The boycott movement also proved to be a serious problem in Gujarat and Belgaum Divisions.

There are at present 6 PURCHASE AND SALE UNIONS in the Presidency. Out of these, the West Khandesh District Purchase and Sales Union continues to flourish. Besides arranging to sell cotton and ground-nut, worth Rs. 2,31,242, and Rs. 39,640 respectively, the Union arranged for ginning of *Kapas* (seed cotton) worth Rs. 82,213 and for the supply of seed and other agricultural requisites worth Rs. 138,509.

Of the eleven MANURE SOCIETIES only six did a fairly large amount of business and sold 386 thousand lbs. of manure and earned a profit of Rs. 1,145. There is very little scope of developing

societies of this type, for the same work is being taken up by purchase and sales unions.

Out of the MACHINERY AND IMPLEMENT SOCIETIES only one has met with a fair amount of success. The society installed a power-crusher, run by an oil-engine at Nanda, and earned Rs. 520 as profit by renting it to the agriculturists. Other implement hire societies have not proved successful, probably because the ploughs they stock cost so little that it pays members to buy rather than to hire them from the society.

Of the three DAM CONSTRUCTION SOCIETIES one was cancelled. Out of other two, Mutta Dam Construction Society has proved very successful. It puts a temporary dam across the river every year to prevent the sea water coming in and to raise the level of river water for irrigation purposes. This scheme has enabled members to get water for irrigating garden lands and for sugarcane.

There are 14 FENCING SOCIETIES. The Kunnur Fencing Society constructed a five-and-a-half miles of wire fence at the cost of Rs. 12,000 which has encouraged cultivators to go in for sugarcane. The other societies in this class are working fairly well.

TALUKA DEVELOPMENT ASSOCIATIONS, of which there are 81, popularize the use of improved seeds, manures and implements by holding demonstrations and agricultural shows. All of them are financially sound and doing good propaganda work. In some places they are running their own fruit farms from which they supply seedlings, etc., to the cultivators.

Punjab.—The number of agricultural societies increased from 16,473 to 17,541, the membership from 504,907 to 569,296 and the working capital from Rs. 731 lakhs to Rs. 849 lakhs during two years under review. Of these 16,309 are pure agricultural credit societies. The activities of the department were centralized towards the expansion of the societies that already existed and, as a result, 30 thousand new members joined the already existing societies in the last year. Nearly Rs. 356 lakhs were advanced as loan to the members and if we add to this the previous unpaid debt, the outstanding loans at the end of 1930-31 amounted to Rs. 718 lakhs. This gives an average debt per member, whether indebted or not,

of Rs. 144 which is little more than the previous year. As in the previous years, purchase of cattle, revenue and payment of old debts are the most important items for which the loans were granted.

LAND MORTGAGE BANKS, which are 12 in number, show very little profit for they have been badly hit by the collapse of prices of the agricultural commodities. At a time, when agricultural enterprises hardly show any return and the repayments of credit societies are correspondingly difficult to get, it is hard to expect any substantial gain in the dealings of Mortgage Banks. Accordingly, for this reason and also as a measure of economy whereby to help Government, the Registrar surrendered the whole of Rs. 8 lakhs that had been budgetted for as available for granting loans to Mortgage Banks through the Provincial Bank. At a Conference held at Lyallpur to consider the situation as regards the business of these banks it was decided that in view of the present conditions of zemindars, the instalments due from borrowers should be reduced by 50 per cent; secondly that in future loans should be limited to 5 times the land revenue and lastly that loans for redemption of land and payment of old debt should cease to be given.

Consolidation of holdings continues to be one of the main activities of the Co-operative Department. Two-hundred-and-fifty-five new societies were registered during the last two years, which bring the grand total of the CONSOLIDATION OF HOLDING SOCIETIES to 795. In the year 1930-31 these societies consolidated 72,821 acres which were split up in 118 thousand blocks; the number was reduced to 21,627 blocks. The total cost to the Government of consolidation this year was Rs. 1.26 lakhs, which works out to Rs. 1.12 per acre. As all prospects of enhancing assessment in the future seem to have vanished, it can be said that Government will reap no material benefit from its expenditure. In spite of all the success, the difficulties of convincing the cultivators of the merits of this movement continue. There is still but little to indicate, that if Government were compelled to retrench the consolidation staff, which is only temporary, any more land would be consolidated at all.

There are at present 3 UNIONS and 18 SOCIETIES FOR AGRICULTURAL PURCHASE AND SALE. Most of them are in Criminal Tribes Settlements, situated in the Multan Circle. Only one of these seems to have done good business. It sold 920 maunds of improved seeds and a full wagon of salt.

Co-OPERATIVE COMMISSION SHOPS for the sale of agricultural produce numbered 25 with 3,595 individual members and 1,280 society members. The value of produce sold went down from Rs. 47 lakhs in 1928-29 to Rs. 30 lakhs in 1930-31 though the amount of produce handled actually increased during this period. Regarding business there was no difficulty during the year but due to fear of making the shop unpopular or from sheer inability to say no, too much credit was expended which resulted in more than Rs. 5,000 of bad debts. A few troubles on a much smaller scale have been caused by advancing money on the security of produce, and not demanding more security when the price of the produce fell or selling it in time. For such faults it is the management who are to be blamed.

Of the thrift societies the most important group is the CROP FAILURE RELIEF SOCIETIES which number 62—an increase of 47 in the last 3 years. These have accumulated Rs. 4,896 in contributions, which has been swelled to Rs. 5,309 by interest. Besides these there are 11 LAND REVENUE REDEMPTION SOCIETIES and three FODDER STORAGE SOCIETIES in Hissar.

Assam.—In the last two years the number of agricultural co-operative societies increased from 1,234 to 1,304, membership from 53 thousand to 55 thousand and the working capital from Rs. 26 lakhs to Rs. 30 lakhs. Though there is an increase in the number of societies yet a considerable number are not in a flourishing condition. This is reported to be mainly due to defective organization, insufficient and inefficient supervision, and the absence of sufficient co-ordination between the Central Bank and their affiliated societies. Due to the large outstanding debts the policy of giving new loans was contracted. The Agricultural Department which used to sell seeds and implements to the agriculturists through the co-operative societies on credit, adopted the policy of cash sales and thus sold goods worth Rs. 1,471 in 1930-31 as against Rs. 21,381 (on credit)

in the year previous. That shows how little cash there is with the farmers. The Co-operative Department devoted time and attention towards consolidation rather than to expansion. The registration of several new societies from localities where there was a persistent demand had to be refused for want of an adequate staff for supervision. Out of the five LAND MORTGAGE BANKS, all but one continue to make steady progress.

Central Provinces and Berar.—In the two years under review, the agricultural co-operative movement showed a definite advance in the first year, for the number of credit societies increased from 3,787 to 3,950, membership from 57 thousand to 59 thousand and the working capital rose from Rs. 162 lakhs to Rs. 171 lakhs. While in the second year there was a marked set back; the number of these societies fell from 3,950 to 3,915, membership from 59 thousand to 58 thousand and the working capital from Rs. 171 lakhs to Rs. 167 lakhs. This was due to the fall of agricultural prices which made it harder for the members to pay back their loans which were advanced on the prices prevailing in the past. Under such conditions the work of reorganising was pushed ahead which resulted in the elimination of weak societies. 196 societies were cancelled last year and though 161 new societies were registered, there was a net loss of 35 in total.

The number of agricultural non-credit societies, however, increased from 21 to 42, membership from 1,865 to 2,289 and the working capital from Rs. 1·4 lakhs to about Rs. 3 lakhs. The 8 co-operative commission shops which were organized to sell the produce of their members in the market did good work during the two years.

Delhi.—Unfavourable agricultural conditions and fall in the prices of agricultural commodities have concentrated efforts on the maintenance of the movement, avoiding expansion in agricultural credit. In the course of 12 years agricultural credit has touched 165 villages, representing 54 per cent. of the total number in the province. The number of agricultural societies decreased from 236 to 221 and there was a corresponding small decrease in the membership from 5,511 to 5,423, but there was a slight increase in

the working capital which went up from Rs. 7.4 lakhs to 8.7 lakhs. The old societies, which have completed their tenth year, have introduced a compulsory deposit system for a period of 5 years.

Though there is no society for the women alone, there are a few widows in the village credit societies who are members in place of their deceased husbands. They are more punctual and scrupulous repayers than the male members.

The consolidation of holdings was taken up in one village where 905 acres distributed in 3,444 fields were consolidated into 376 blocks. The average area per field has been increased from 0.26 to 2.4 acres, *i.e.*, nearly ten times.

Bengal.—The two years under review were by no means prosperous ones, for the adverse economic conditions imposed on the movement a much severer strain than it had ever had to face. This rendered necessary the adoption of a policy of caution in matters of expansion and most of the energies were directed towards consolidation of the movement. During 1929-30, the position of co-operative societies was examined by the Bengal Provincial Banking Enquiry Committee which pointed out 3 main defects in the movement namely, the illiteracy of members and their ignorance of co-operative principles, heterogeneous membership, and delay in obtaining loans by primary societies. Another defect of the movement brought to light was the failure on the part of many Central Banks and most credit societies to distinguish between long and short-term credit and the practice hitherto followed by many of these institutions of investing short-term capital in long-term loans. In spite of this the number of agricultural societies increased from 18,009 to 21,506, membership from 478 thousand to 536 thousand and the working capital from Rs. 470 lakhs to Rs. 561 lakhs during the two years ending with 1930-31.

AGRICULTURAL CREDIT SOCIETIES constitute the bulk of registered co-operative societies and comprise 85 per cent. of the total number. The actual number of societies including Grain Banks rose from 16,930 to 20,172, membership from 408,980 to 476,962 and the working capital from Rs. 421 lakhs to Rs. 538 lakhs. During the years under review there was a big drop in recoveries of loans by

agricultural credit societies, and this was due to the collapse in the prices of agricultural commodities. Of the Grain Banks only a few are doing useful work. Others are either in a moribund condition or are existing nominally.

The number of AGRICULTURAL PURCHASE AND SALE SOCIETIES declined from 100 in 1928-29 to 95 in 1930-31. The membership also decreased from 28,982 to 12,935 and the working capital from Rs. 37 lakhs to Rs. 7 lakhs during the same period. The decrease was mainly due to the closing down of the jute sale societies which failed and became insolvent. The paddy sale societies, though affected by the general trade depression, managed to work well on the whole and some of them did quite good business during this period.

The number of irrigation and drainage societies rose in two years from 773 to 929 and their membership from 20,133 to 23,747. As many as 915 of these societies are in Burdwan division where they are generally doing useful work. There is still a great scope for the promotion of these societies in the same division, particularly in the undulating districts where the annual rainfall is comparatively small and is not well distributed.

The other types of societies worth mentioning are the CO-OPERATIVE AGRICULTURAL ASSOCIATIONS which are 38 in number and PRODUCTION AND SALE SOCIETIES the bulk of which are really milk societies. In spite of the drop in prices the milk societies continue to work at a profit and it is gratifying to know that a part of their profit is devoted to local works of public utility, such as the establishment of schools and the sinking of tube-wells within their areas. Co-operative activities have also been extended to silk manufactures. The Bengal Co-operative Silk Union, which was established in 1927 to organize workers in sericultural industry and silk manufacture and generally to pursue a policy for the development of the industry, is financing 32 affiliated silk societies of mixed type with 558 rearers, reelers or weavers as members. The Union is a co-operative body and is the good result of collaboration between Mr. Peddie, the Collector of Malda, the Department of Co-operative Credit and the Sericultural Section of the Department of Agri-

culture. The object of the Union is to organize rearers to pool their produce to be worked up and marketed as an aggregate.

North-West Frontier Province.—Progress in the field of agricultural co-operation is considered to be adequate and further expansion is being undertaken with caution. The number of AGRICULTURAL CREDIT SOCIETIES increased from 89 to 239, membership from 2,500 to 5,923 and the working capital from Rs. 2.1 lakhs to Rs. 5.39 lakhs. The main efforts of the co-operative staff was to consolidate and improve the existing societies which, in spite of the political unrest and economic disturbance, worked well during the period under review. Great attention was also paid towards the training of the members and this was directly imparted by the Inspectors themselves. One great feature of the movement is that women are joining the credit societies.

The total amount of loans at the end of the year was Rs. 5.15 lakhs. The maximum credit limit of the members was reduced and the loans were confined to productive purposes only.

The work of consolidation of holdings was undertaken in 4 villages; and the number of blocks were reduced from 1,652 to 290.

United Provinces.—Some little progress is noticeable in the development of non-credit agricultural societies though there has been a marked and steady deterioration in the working of the credit side of the agricultural co-operative movement. The total number of agricultural credit societies decreased from 5,390 in 1928-29 to 5,044 in the next year and to 5,010 in 1930-31; consequently the membership figures fell from 1.27 lakh to 1.13 lakh in these two years. The decline would have been greater but for the fact that 350 societies which were on the verge of liquidation were re-organized and in addition 180 new societies were registered in the last year. Though the economic conditions all round were not favourable, yet the financial condition of societies continued to show improvement. Their reserve fund increased from Rs. 22.9 lakhs in 1929-30 to 24.7 lakhs in 1930-31 and their owned capital is now Rs. 50.5 lakhs or nearly half the total working capital. The profits made during the year went up from Rs. 6.5 to 6.9 lakhs and losses decreased from Rs. 50 to 12 thousand. There are 2,595 societies

now of over 10 years' standing and out of this number nearly 11 hundred of them were able to distribute dividends to the extent of Rs. 41,000. The loan outstanding with members decreased from Rs. 83·7 to Rs. 82·5 lakhs in the last two years, while the overdues went up from Rs. 32·3 to 53·7 lakhs.

SUPPLY AND SALE SOCIETIES.—The Sugarcane Sale Union at Ghugli, in the Gorakpur district, was able to expand its business from 53,000 to nearly one lakh of maunds of cane without increasing the number of its member societies which is still 16. There is still a considerable scope for expansion. The ghee sale societies had a very bad time due to the fluctuations in the price of ghee, yet out of 11 such societies only two worked at a loss. The total amount of ghee handled by these societies was about 250 maunds. Out of the 5 agricultural supply societies in 1929-30 there only remain 3 and none of them is working at a profit. The field of co-operation has been extended to the poultry business and 4 societies were registered for selling poultry products.

Bihar and Orissa.—The number of agricultural co-operative societies increased from 8,715 to 8,799 in the two years under review, though the yearly figures show that there was an increase of 102 in the first year and a decrease of 18 in the second. The membership figures showed a decrease of 8,839 in 1929-30 followed by another decrease of 1,437 in the next year. The working capital now stands at Rs. 236 lakhs which again shows a fall of Rs. 5½ lakhs from the last year's figures. On account of the policy of caution followed by the banks on one hand and the reluctance on the part of the societies themselves on the other, the total amount of loan advanced to the members showed a heavy fall, amounting to Rs. 16·3 lakhs as against Rs. 33·6 lakhs in 1929-30 and Rs. 64·5 lakhs in the previous year.

Primary credit societies numbering 8,718 formed the great bulk of the total number of societies in the province with 213,137 members and working capital of Rs. 231·9 lakhs. The monopolisation of the bulk of the loans by a small number of rich and influential members was an evil which received serious attention. Such people become the members of the managing committees and are

often directors of the banks. They generally are the worst defaulters but in the long run it is the entire membership which suffers the whole loss due to unlimited liability of the society's debt. An investigation into the matter showed that 40 per cent. of the loans are advanced to 25 per cent. of the total membership.

The most popular of all the agricultural non-credit societies are the GRAIN Golas which are 68 in number with a membership of 20,552 and a working capital of Rs. 3·7 lakhs. The LAND IMPROVEMENT SOCIETIES, which come next in importance, lent to their members Rs. 24 thousand of which Rs. 13·6 thousand were spent on reclamation of waste land, Rs. 4,576 in sinking wells and the rest in constructions of bundhs and other similar purposes. There were also three IRRIGATION SOCIETIES, but on the whole their work was not satisfactory and all of them resulted in a net loss. The 3 PURCHASE AND SALE SOCIETIES were also in a very bad financial condition and need to be wound up in the near future.

Some activities of the central banks in the direction of agricultural and land improvement need special mention. Some of these banks took part in the distribution of improved seeds and the progress was especially marked in the cultivation of cotton, wheat, sugarcane, barley and certain other crops, and some others distributed manure and, in co-operation with the Agricultural Department, carried out demonstrations of improved agricultural implements. Lack of funds restricted such activities but the progress, though slow, is very marked in some places, particularly in Orissa.

Mysore.—The number of RURAL CO-OPERATIVE SOCIETIES rose from 140 in 1928-29 to 177 in 1930-31. Their activities mainly consist in stocking of implements, seeds and manures for sale to their members, and in 1929-30 they did business worth Rs. 60 thousand. Four of these societies took over practically the whole of the sales and distribution work in their respective taluks from the Department of Agriculture and were responsible for the supply of implements, seeds and manure to a total value of nearly Rs. 30 thousand. The Co-operative Society of Maradihally ginned and marketed the crops of the village in a pure condition.

The Agricultural and Experimental Union did very valuable work in the way of testing improvements recommended by the Department of Agriculture. Valuable results were obtained from the testing of Satara ploughs, improved varieties of seeds and new chemical manures on various crops. The Union employed at their own cost two special fieldmen for a period of 4 months to help the local offices in the work of collecting results during harvest.

VILLAGE PANCHAYATS have been brought into the scheme of agricultural development for the purposes of propaganda and demonstration work. In 1930-31 there were 716 such organizations and these mostly confined their operations to the purchase of improved implements for demonstration in the villages.

2. Co-operative Cotton Sale Societies.

In spite of the hard times due to the trade depression on one hand and the boycott movement on the other, the co-operative cotton sale societies did a fair amount of business. The number of these societies in BOMBAY was 24, out of which 7 were in the southern division, one in Khandesh, one in Belgaum and the rest in northern division. In the southern division Hubli and Gadag societies, as in previous years, continued to be the most important ones. The Gadag society increased its reserved area from 14,000 to 23,652 acres and sold about 85,390 mds. of cotton during 1931. The society, however, lost in the seed business to the extent of Rs. 13,187. The Hubli sales society sold 54,766 mds. of cotton but lost Rs. 9,325 in the seed business. The loss in both the cases was due to wrong estimating and over-stocking. These two societies, however, are the best of their kind throughout India and have co-operated with the Agriculture Department in the distribution of improved cotton seed throughout the division. The societies in the northern division did fairly good business. The Bail-Hongal cotton sale society in Belgaum division was boycotted by the local dealers and all efforts to lift the boycott failed with the result that the cotton had to be taken to a ginning factory 20 miles off and then sent to Bombay for sale. The Pachora cotton sale society in Khandesh sold 16,140 mds. of cotton for Rs. 59,212.

In the MADRAS PRESIDENCY the Deputy Director of Agriculture appointed under the Registrar of Co-operative Societies for the development of cotton, loan and sale societies in the principal cotton areas, took charge in March 1931. There are at present five societies in the Presidency dealing in cotton. They are at Tiruppur, Trichengode, Koilpatti, Nandyal and Bellary. Besides these, there are a number of registered and unregistered Seed Societies and Unions who obtain seed of improved types of cotton from the Agricultural Department, grow and dispose of the produce under departmental control, the Department buying back the seed at a premium.

In the PUNJAB there were 25 co-operative commission shops which sold produce of their members worth 30 lakhs of rupees. This includes all kinds of stuff but cotton and wheat are the most important. The Okara Sale Society continues to function with success and sold 279,611 mds. of produce worth Rs. 9.29 lakhs of which cotton was the most important item.

CHAPTER XI

PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS.

A list of agricultural publications issued during the two years under review is given in Appendix XIII. The change which took place towards the end of the period in the names and editorship of the publications issued by the Imperial Department of Agriculture has been recorded in Chapter I. Publications of the Imperial Department of Agriculture during the two years numbered 34 memoirs (15 botanical, 16 chemical, 2 entomological and 1 bacteriological) and 11 bulletins.

A reference to the contents of the journals and memoirs will show the wide range of subjects covered and their practical application. Many of the publications deal with completed investigations the results of which have been discussed elsewhere in this Review. As usual most of the scientific work done in the provinces was published in these series.

Provincial and State Publications.—The Department of Agriculture, Madras, issued 20 leaflets and 16 other publications during the period, many of these being also issued in the important vernaculars of the Presidency. The “Villagers’ Calendar” continued to be printed in English and the principal vernaculars, the size of the edition running to nearly a lakh every year. The publication of the year-book was discontinued from 1929, and the monthly digests were converted into quarterlies from the same year and were issued in English as well as in the main vernaculars.

The Bombay Department of Agriculture issued 7 bulletins and 29 popular leaflets, the latter also in most cases in the appropriate vernaculars.

In Bengal 23 leaflets, embodying the practical recommendations of the Department, were published during the years under report.

In the United Provinces, the two departmental vernacular agricultural journals, the “Mufid-ul-Mazarin” and “Kisan Upkark” continued to be issued regularly, the circulation amounting

to nearly 1,500 in each case. The departmental bulletins issued during the period numbered 24.

The Punjab Agricultural Department continued to publish the "Seasonal Notes" half yearly and also issued 37 leaflets during the period. The Punjab Board of Economic Inquiry published two important publications, *viz.*, (1) "Farm Accounts in the Punjab, 1928-29 (being the fifth year's accounts of certain farms with new sections with special reference to Well Irrigation in the Punjab)", by H. R. Stewart and S. Kartar Singh, and (2) "Report on a Preliminary Survey of the Milk Supply of Lyallpur in 1927", by S. Labh Singh.

The Department of Agriculture, Burma, continued to publish the "Agricultural Calendar", nearly 8,000 copies being printed and distributed every year. In addition, two "Cultivators' Leaflets", 4 bulletins and 2 "Agricultural Surveys" were also issued during the period.

The Bihar and Orissa Agricultural Department issued 12 leaflets and bulletins containing the practical recommendations of the Department.

In Assam the Department of Agriculture issued 8 bulletins and leaflets.

In Mysore the Department published an "Agricultural Calendar" in English as well as in Kannada each year and in addition 9 bulletins and in Travancore the Agricultural Department issued two leaflets.

CHAPTER XII

RECEIPTS AND EXPENDITURE OF THE AGRICULTURAL AND VETERINARY DEPARTMENTS.

The following tabular statements show the expenditure and receipts of the Agricultural and Veterinary Departments of the Imperial and Provincial Governments for the three years 1928-29 to 1930-31.

Agriculture.

Name.	1928-29.		1929-30.		1930-31.	
	Expendi- ture.	Receipts.	Expendi- ture.	Receipts.	Expendi- ture.	Receipts.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Punjab	27,56,109	7,09,133	29,24,764	9,60,531	26,74,380	6,02,037
United Provinces	25,22,714	4,45,021	24,23,361	4,93,447	23,75,295	4,55,280
Madras	18,35,350	3,04,727	19,48,385	2,04,224	20,20,650	2,28,190
Bombay : Presidency proper	18,28,300	2,59,700	18,03,800	2,85,750	14,35,005	2,18,211
Sind					3,48,991	44,205
Imperial Department of Agriculture	16,64,613	4,30,059	16,71,864	5,46,039	15,60,002	4,79,113
Central Provinces	11,05,870	3,82,130	11,78,853	3,71,245	11,20,025	3,64,110
Bengal	11,21,619	1,60,411	10,87,713	1,50,018	10,76,463	1,14,932
Burma	9,40,958	1,15,850	10,53,834	1,29,092	9,76,059	95,009
Bihar and Orissa	6,84,943	1,67,210	7,45,987	1,50,640	6,80,937	1,20,789
Assam	3,84,417	82,587	4,57,841	88,294	4,60,441	82,235
North-West Frontier Province	90,698	24,676	90,970	24,834	70,990	20,868
Baluchistan	10,202	10,830	10,814	12,859	17,793	10,204
	1,48,13,871	31,03,152	1,53,46,262	34,99,879	1,48,41,472	29,27,368

Veterinary.

Name.	1928-29.		1929-30.		1930-31.	
	Expenditure.	Receipts.	Expenditure.	Receipts.	Expenditure.	Receipts.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Punjab*	13,02,167	2,00,720	14,00,012	2,27,562	12,40,893	1,80,139
Madras	10,32,201	20,730	11,82,754	32,008	11,67,048	35,204
Imperial Institute of Veterinary Research, Muktesar, and the Izatnagar Sub-Station.	7,63,050	14,00,000	7,77,321	15,60,237	8,20,400	12,00,381
Burma	0,41,000	1,383	6,30,000	935	0,38,000	1,070
United Provinces	4,55,281	08,451	5,30,025	1,80,195	5,32,852	1,11,146
Bombay	6,17,634	10,074	4,54,332	11,561	4,76,600	8,780
Central Provinces	4,38,743	1,386	4,47,030	2,357	4,25,880	1,037
Bengal	5,41,547	1,73,348	4,34,003	1,20,585	4,10,455	1,03,835
Bihar and Orissa	4,30,200	1,04,151	4,10,251	1,26,553	4,42,272	1,21,006
Assam	1,32,298	38,361	2,04,305	1,696	1,81,067	1,098
North-West Frontier Province .	05,730	..	80,037	..	78,860	4,680
Baluchistan	77,035	3	74,200	328	74,080	344
TOTAL	04,82,208	21,55,503	06,63,930	22,29,097	63,05,921	17,71,385

* Excluding Breeding Operations.

As foreseen in the last Review, shortage of money checked the steady advance that had been going on for the last twenty-five years, rendered any large expansion impossible and in some provinces led to the curtailment of existing forms of assistance to the agriculturist. However, in spite of this handicap, the essential services were maintained in an efficient condition. The present agricultural depression caused by the world-wide collapse in the prices of almost all primary commodities calls for increased efficiency in production and this implies undiminished grants for investigation and research. Perhaps the point cannot be better stated than in an extract from the proceedings of the Imperial Conference of 1930 :—

“It is important that investigations, once begun, should not be subject to unreasonable interruptions because of financial stringency. There is a real danger in times of financial stress that governments may be tempted to economise in expenditure on scientific services on the ground that the need for them is less urgent than for other forms of expenditure, and that research can well be

put on one side until prosperous conditions return. In the opinion of the Research Committee, the need for the conduct of scientific enquiries, and the application of the knowledge gained thereby, is more urgent when industries are depressed than when they are flourishing. Research cannot be expected to yield fruitful results if it is pursued in fits and starts. The Committee have embodied these views in the following resolution :—

“The Research Committee of the Imperial Conference, being convinced that progress will in future be dependent to an increasing extent upon the growth and application of scientific knowledge, desire to direct the attention of the various Governments of the British Commonwealth of Nations to the importance of making adequate provision from State funds for the steady pursuit of scientific research into the various problems affecting the material well-being of mankind. They also desire strongly to urge their view that the severe economic depression from which the British Empire, in common with the rest of the world, is now suffering, should be regarded as a reason not for the curtailment but for an expansion of expenditure on research. The greater utilisation of the help which science can give will be a potent factor in the rehabilitation of existing industries, including agriculture, no less than in the development of new ones.”

Burma	Sugarcane (Colombatore)	5,230*	78,070*	83,318	3,850	70,150	80,000	--	--	104,400
	Paddy	123,895	190,230	323,125	120,002	250,310	382,072	147,033	280,171	486,804
	Groundnut	1,055	12,028	13,083	420	13,930	14,350	409	20,501	20,970
	Cotton	4,520	2,050	0,570	4,000	1,002	5,002	4,800	4,500	9,390
	Gram	8,005	147,021	168,110	2,034	127,422	186,350	20,711	124,575	145,280
	Sugarcane	--	--	--	--	--	1,731	--	--	250
	Paddy—									
	Dahla	1,047	12,744	13,701	1,201	15,306	10,597	050	7,001	8,044
	Kakharua, Kalamdan, Cutlack Nos. 1, 2, 3 and 4, Lat-nail, etc.	131	0,303	0,454	1,631	4,820	0,460	145	0,945	7,000
	TOTAL PADDY	1,108	19,047	20,215	2,832	20,225	23,037	1,005	14,039	15,134
Bihar and Orissa	Sugarcane (Co. 205, 213)	1,306	14,722	40,088	884	80,760	91,004	336	101,782	102,118
	Groundnut (No. 17)	47	2,500	2,607	120	2,455	2,575	715	1,667	2,382
	Tobacco (Pusa 28)	25	215	210	60	480	540	--	500	500
	Gram (Sabour No. 4, Pusa No. 17)	90	301	307	02	413	475	28	890	917
	Wheat (Pusa 4, 12, 52, 50-5)	319	4,870	5,108	2,208	0,254	8,462	1,981	21,225	23,206
	Miscellaneous (Pusa Linseed 12, Sabour Teas 512, Dhalncha, Mafze, Rthar, Elephant grass and Jute D. 154)	84	54	138	115	235	350	200	970	1,242
	Wheat	--	--	269,007	--	--	355,057	--	--	377,372
	Paddy	--	--	181,090	--	--	220,076	--	--	254,781
	Cotton	--	--	027,071	--	--	060,109	--	--	088,005
	Juar (Sorghum)	--	--	120,773	--	--	102,549	--	--	153,282
Central Provinces	Groundnut	--	--	75,024	--	--	85,170	--	--	115,831
	Sugarcane	--	--	--	--	--	1,350*	--	--	4,208*
	Other crops	--	--	20,187	--	--	10,400	--	--	37,343

* Figures supplied by the Sugar Technologist, Imperial Council of Agricultural Research.

	TOTAL COTTON	..	..	82,900	94,500	82,900	..	82,800	114,100	..	114,100
	Groundnut (Kanki No. 17).	..	..	91	..	..	..	91	310	..	340
	Sugarcane (Co. 213)	..	..	..	..	..	..	..	20	..	20
	Ragi H. 22	22,310	50,818	50,088	70,178	50,088	138,050	189,038	35,441	98,225	133,000
	Paddy	2,252	11,270	2,805	13,522	2,805	28,003	30,909	3,677	34,482	38,159
	Sugarcane	1,240	3,118	627	4,364	627	2,804	3,621	1,781	4,032	6,413
	Cotton	6,610	5,080	8,087	11,710	8,087	8,235	10,072	11,043	12,120	23,103
	Groundnut	2,067	69,886	1,113	72,153	1,113	60,191	67,591	711	105,205	106,000
	Miscellaneous (Jola, green manure, cardamom, pota- toes, pepper, wheat, sun- flower).	122	203	211	387	211	530	771	302	12,634	12,996
	Cotton	11,250	..	5,251	..	5,251	70,803	85,054	6,897	..	..
	Paddy	250	..	70	..	70	8,050	8,120	56	105	101
	Wheat	60	..	55	..	55	1,000	1,001	35	..	..
	Paddy	438	..	350	..	350	750	1,100	261	1,000	1,261
	Cotton (Malawi)	4,189	..	2,500	..	2,500	..	..	..	..	..
	Jowar	913	..	4,000	..	4,000	..	..	..	..	..
	Wheat (Jalalia and Pusa I)	1,909	..	500	..	500	..	..	..	..	..
	Wheat	..	..	..	..	..	..	..	45,060	310,790	356,750
	Cotton	..	..	..	..	..	..	..	2,400	102,600	165,000

* Figures not available.
† Areas shown are approximate. Figures for 1929-30 have been revised.

APPENDIX II.

List of Agricultural Stations in India in 1929-30 and 1930-31.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	REMARKS
Imperial Department of Agri- culture in India.	Pusa	720-732*	Farm Overseer	Imperial Agriculturist	Imperial Institute of Agri- cultural Research. * Cultivated area.
	Karnal	2,154	Superintendent	Imperial Dairy Expert	Cattle-breeding Farm.
	Bangalore	291	Ditto	Ditto	Dairy Farm.
	Wellington	149	Ditto	Ditto	Ditto.
	Colombatore	90	Farm Manager	Sugarcane Expert	Cane-breeding Station.
	Annapalle	30	Ditto	Deputy Director of Agricul- ture, I Circle, Vizagapatam.	
	Samalkota	57	Ditto		
	Guntur	150	Ditto	Deputy Director of Agriculture, II Circle, Guntur.	
	Itacari	225	Ditto	Deputy Director of Agricul- ture, III Circle, Bellary.	
	Nandyal	88	Ditto		
	Talur	61	Ditto	Deputy Director of Agricul- ture, IV Circle, St. Thomas Mt.	
	Palakuppam	10	Ditto		
	Colmbatore (Cotton-breeding Station)	103	Superintendent	Cotton Specialist, Colombatore.	
	Kollipatti	205	Ditto		
	Kasaragod	100	Farm Manager	Deputy Director of Agricul- ture, VII Circle, Tellicherry.	
	Taliparamba	80	Ditto		
Madras	Vellalur	2	Ditto	Deputy Director of Agriculture, VIII Circle, Colombatore.	Betel Vine Station.
	Colmbatore (Central Farm)	314	Ditto	Principal, Agricultural College, Colmbatore.	Central Farm attached to the Agricultural College.

Bombay Presidency (proper)				Live-stock Research Stations.	
Colombatore (Paddy-breeding Station)				Paddy Specialist, Colombatore.	
Adithural	.	.	.	Superintendent	.
Maruturu	.	.	.	Ditto	.
Pattambal	.	.	.	Ditto	.
Colombatore (Millet-breeding Station)				Millet Specialist, Colombatore.	
Hezur	.	.	.	Farm Manager	.
Chintaladevi	.	.	.	Superintendent	.
Guntur	.	.	.	Ditto	.
Nausanad	.	.	.	Farm Manager	.
Coonor. Pusthar and Kallar Gardens.	.	.	.	Ditto	.
Surat	.	.	.	Assistant Farm Manager	.
Amalnad	.	.	.	Superintendent	.
Nadlad	.	.	.	Agricultural Overseer	.
Broach	.	.	.	Tobacco Breeder, Nadlad	.
Dohad	.	.	.	Cotton Breeder, South Gujarat, Surat.	.
Viramgam	.	.	.	Superintendent, Agricultural Station, Dohad.	.
Jalgaon	.	.	.	Cotton Breeder, North Gujarat, Viramgam.	.
Dhulia School Farm	.	.	.	Superintendent	.
Sangvi Farm	.	.	.	Head Master, Vernacular Agricultural School, Dhulia.	.
				Manager, Sangvi Farm	.
				Deputy Director of Agriculture, N. C. D., Nasik.	
				Deputy Director of Agriculture, Gujarat, Surat.	
				Curator, Government Botanical Gardens and Parks, Ootacamund.	
				Deputy Director of Agriculture, Live-stock, Hezur.	
				Pomological Station. 12 acres. Pusthar Gardens : 8 " Kallar Gardens : 10 "	
				Research and experiments in cotton and jowar breeding, maintaining and multiplying pure seed for distribution.	
				Closed from 28th February 1931 due to retrenchment.	
				Improvements in local varieties of tobacco for breeding the best strains and multiplying pure seed for distribution.	
				Breeding of cotton and jowar types.	
				Improving staple crop of maize, wheat, gram by selection and breeding. First-resistant variety of cotton.	
				Improvement in local types of Wagad by breeding and selection.	
				Cattle-breeding Farm.	

List of Agricultural Stations in India in 1929-30 and 1930-31—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	REMARKS
Bombay Presidency (proper) <i>contd.</i>	Kopergaon	25	Superintendent, Kopergaon Farm.	Deputy Director of Agriculture, S. O. D., Poona.	Sugarcane Station. Closed from 1st June 1931.
	Baramati	21	Superintendent, Baramati Farm.		Sugarcane Experimental Station.
	Manjri	72	Superintendent, Manjri Farm.		This Farm is maintained for testing and showing methods of dry cultivation and land development in famine areas.
	Mohol	55	Overseer		
	Dharwar	148	Superintendent, Dharwar Farm.	Deputy Director of Agriculture, S. D., Dharwar.	
	Gokak	32	Superintendent, Gokak Farm.	Ditto	
	Mugad	9	Superintendent	Ditto	Rice-breeding Farm.
	Tegur	370	Fieldman	Ditto	Cattle-breeding Farm.
	Ratnagiri	22	Superintendent	Deputy Director of Agriculture, Konkarn, Ratnagiri.	Rice breeding.
	Hatkhamba (Varkas Sub-Station)	71	Ditto	Ditto	Nagli breeding.
	Kumta (Forest attached to the Farm—35 acres).	23	Ditto	Ditto	
	Karjat	9	Rice Specialist, Karjat	Ditto	Rice Research Station.
	Karjat	6	Superintendent	Crop Botanist to Government, Karjat.	Rice-breeding Station.
	Niphad	5	Ditto		Wheat-breeding Station (transferred from Kirkee in 1930-31).
	Chharodli	2,278	Manager	Live-stock Expert to Government, Poona.	Cattle Farm.
	Bankapur	(1) 98 (2) 152	Ditto		(1) Farm area.
	Goneshkhind	80	Superintendent		(2) Grazing area at Kalasgeri attached to Farm.

List of Agricultural Stations in India in 1929-30 and 1930-31—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	REMARKS
Bengal—contd.	Gosaba (24-Farganas)	8	Agricultural Officer, Gosaba District Agricultural Officer, Jessore.	Deputy Director of Agriculture, Western Circle.	
	Burduwan	5	District Agricultural Officer, Burdwan.		
	Rajshahi	35	District Agricultural Officer, Rajshahi.		
	Patna	63	Superintendent, Rajshahi Farm.		
	Bogra	10	District Agricultural Officer, Patna.		
	Bogra Branch Farm	23	District Agricultural Officer, Bogra.	Deputy Director of Agriculture, Northern Circle.	
	Malda	7	Ditto		
	Dinajpur	16	District Agricultural Officer, Malda.		
	Rangpur Demonstration Farm	24	District Agricultural Officer, Dinajpur.		
	Mahaguri	19	District Agricultural Officer, Rangpur.		
	Rangpur Cattle Farm	25	District Agricultural Officer, Jalpaiguri.		
	Government Tobacco Farm, Rangpur	333	Superintendent, Rangpur Cattle Farm.		Live-Stock Expert, Bengal.
	Dacca Central Farm	52	Superintendent, Rangpur Tobacco Farm.		Agricultural Chemist, Bengal.
	Jaldebpur Farm (Court of Wards)	354	Chief Superintendent, Dacca Farm.		Deputy Director of Agriculture, Eastern Circle.
	Mymensingh Farm	11	Agricultural Demonstrator		Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Dacca.
		20	District Agricultural Officer, Mymensingh.		

Jamalpur	.	.	.	.	35	District Agricultural Officer, Jamalpur.	Deputy Director of Agriculture, Eastern Circle.
Kishoreganj Farm	.	.	.	.	33	District Agricultural Officer, Kishoreganj.	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Kishoreganj.
Dhanbari Farm	.	.	.	.	7	Agricultural Demonstrator	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Kishoreganj.
Gayhatta C. W. Farm	.	.	.	.	4	Ditto . . .	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Jamalpur.
Baratia Private Farm	.	.	.	.	8	Ditto . . .	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Jamalpur.
Faridpur Farm	.	.	.	.	20	District Agricultural Officer, Faridpur.	Deputy Director of Agriculture, Eastern Circle.
Rajbari Farm	.	.	.	.	10	Agricultural Demonstrator, Rajbari.	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Faridpur.
Barisal Farm	.	.	.	.	20	District Agricultural Officer, Barisal.	Deputy Director of Agriculture, Eastern Circle.
Rangamati Farm	.	.	.	.	51	District Agricultural Officer, Rangamati.	Assistant Director of Agriculture, Bengal.
Charhadna Farm	.	.	.	.	67	Agricultural Demonstrator	
Lalmohan Khasmahal Farm	.	.	.	.	6	Ditto . . .	
Chandra Mohan Farm	.	.	.	.	14	Ditto . . .	
Antali Farm	.	.	.	.	1	Ditto . . .	
Bargana Farm	.	.	.	.	3	Ditto . . .	
Khepapara Colonisation Farm	.	.	.	.	6	Ditto . . .	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Barisal.
Daulatkhan C. W. Farm	.	.	.	.	..	Ditto . . .	
Condila Farm	.	.	.	.	20	District Agricultural Officer, Comilla.	
Brahmanbaria Private Farm	.	.	.	.	5	Agricultural Demonstrator	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Comilla.
Char Nikkamal K. M. Farm	.	.	.	.	2	Ditto . . .	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Chittagong.
Durgapur H. E. School Farm	.	.	.	.	5	Agricultural teacher attached to the School.	Assistant Director of Agriculture.
Kalimpong Farm	.	.	.	.	73	Superintendent of Agriculture, Kalimpong.	

List of Agricultural Stations in India in 1929-30 and 1930-31—contd.

Province	Agricultural Stations	Area in acres	Officers in Immediate charge	Supervising Officer	REMARKS
United Provinces . . .	Shahjahanpur . . .	165	Deputy Director	Deputy Director of Agriculture, Kohlikhand Circle.	
	Badam . . .	20	Overseer . . .		
	Nawab Gunj (Bareilly) . . .	120	Ditto . . .		
	Nagina (Bijnor) . . .	77	Superintendent		
	Jodhpote (Naini Tal) . . .	51	Ditto . . .	Deputy Director of Agriculture, Central Circle.	
	Tarikhet . . .	17	Ditto.		
	Cawnpore . . .	71	Ditto . . .		
	Kulluaporo . . .	263	Ditto . . .		
	Melanpuri . . .	53	Ditto . . .	Deputy Director of Agriculture, Bundelkhand Circle.	
	Etawah . . .	61	Ditto . . .		
	Hardol . . .	55	Ditto . . .		
	Attara (Bonda) . . .	171	Ditto . . .		
	Bela Tal (Hamirpur) . . .	30	Overseer . . .	Deputy Director of Agriculture, Eastern Circle.	* Closed from Nov. 1, 1930.
	Partabgarh . . .	60	Superintendent		
	Naugawan (Sultanpur)* . . .	300	Ditto . . .		
	Fyzabad . . .	200	Overseer . . .		
	Benares . . .	78	Superintendent	Deputy Director of Agriculture, Western Circle.	
	Allgarh . . .	88	Ditto . . .		
	Kalal (Allgarh) . . .	142	Ditto . . .		
	Muzaffarnagar . . .	100	Ditto . . .		
	Blehpur (Agra) . . .	100	Ditto . . .		
	Jachonda (Muttra) . . .	35	Inspector		
	Bulandshahr . . .	25	Ditto . . .		

No.	Name	Rank or Position	Remarks
70	Mecrut	Ditto . . . . .	. . . . .
110	Gornkhpur	Overseer	Deputy Director of Agriculture, North-Eastern Circle.
100	Bahraich	Ditto . . . . .	.
425	Lyalpur Agricultural Station	Agricultural Assistant	Professor of Agriculture, Punjab Agricultural College, Lyalpur.
78	Lyalpur Students' Farm	Ditto	Ditto.
113	Lyalpur Botanical Farm and Fruit Garden.	Associate Professor of Bo- tany.	Associate Professor of Botany, Punjab Agricultural College, Lyalpur.
802	Risalewala	Agricultural Assistant	Professor of Agriculture, Punjab Agricultural College, Lyalpur.
220	Cotton Research Botanist Farm, Risalewala.	Cotton Research Botanist	Cotton Research Botanist, Lyall- pur.
18	Cotton Research Botanist Farm, Lyall- pur.	Ditto	Ditto
200	Jhang Farm	Agricultural Assistant	Deputy Director of Agriculture, Lyalpur.
681	Montgomery Agricultural Station	Ditto	Deputy Director of Agriculture, Montgomery.
1,511	Shergarh Farm	Ditto	Ditto
528	Fatna Farm	Ditto	Ditto
550	Dara Farm	Ditto	Ditto
283	Gurdaspur Agricultural Station	Ditto	Deputy Director of Agriculture, Gurdaspur.
36	Beas Farm	Ditto	Ditto
101	Attari Farm	Ditto	Ditto
107	Gujranwala Farm	Ditto	Ditto
381	Kala Shah Kaku Rice Farm	Ditto	Ditto
252	Rawalpindi Agricultural Station	Ditto	Deputy Director of Agriculture, Rawalpindi.
100	Campbellpur Farm	Ditto	Ditto
45	Gujrat Farm	Ditto	Ditto

List of Agricultural Stations in India in 1929-30 and 1930-31—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	REMARKS
Punjab—contd.	Chillianwala Seed Farm . . .	250	Agricultural Assistant .	Deputy Director of Agriculture, Rawalpindi.	Seed Farm.
	Sargodha Seed Farm . . .	155	Ditto . . .	Ditto . . .	Ditto.
	Sargodha Agricultural Station . . .	500	Ditto . . .	Ditto . . .	Experimental Station and Seed Farm.
	Honai Agricultural Station . . .	589	Ditto . . .	Deputy Director of Agriculture, Hansi.	Experimental Station.
	Sirsa Agricultural Station . . .	402	Ditto . . .	Ditto . . .	Ditto.
	Ferozepore Farm . . .	100	Ditto . . .	Ditto . . .	District Farm.
	Gurgaon Farm . . .	100	Ditto . . .	Ditto . . .	Ditto.
	Totiak Farm . . .	100	Ditto . . .	Ditto . . .	Ditto.
	Amballa Farm . . .	100	Ditto . . .	Ditto . . .	Ditto.
	Karnal Farm . . .	100	Ditto . . .	Ditto . . .	Ditto.
	Multan Agricultural Station . . .	529	Ditto . . .	Deputy Director of Agriculture, Multan.	Experimental Station.
	Vihari Seed Farm . . .	500	Ditto . . .	Ditto . . .	Seed Farm.
	Manwall Farm . . .	297	Ditto . . .	Ditto . . .	District Farm.
	Ludhiana Farm . . .	54	Ditto . . .	Deputy Director of Agriculture, Jullundur.	Ditto.
	Kangra Farm . . .	10	Ditto . . .	Ditto . . .	Ditto.
	Jullundur Agricultural Station . . .	119	Ditto . . .	Ditto . . .	Agricultural Station.
	Himawli . . .	456	Farm Superintendent .	Deputy Director of Agriculture, Southern Circle, Rangoon.	
	Mandalay . . .	630	Ditto . . .	Professor of Agriculture, Mandalay.	
	Kanbalu . . .	534	Ditto . . .	Deputy Director of Agriculture, Northern Circle, Mandalay.	
	Mahalaing . . .	254	Ditto . . .	Deputy Director, Myingyan Circle, Moulmein.	

Burma	Pymmana	55	Ditto	Deputy Director, East Central Circle, Pymmana.	
	Taikon	106	Ditto		
	Alammyo	144	Ditto	Deputy Director, West Central Circle, Magwe.	
	Sa-ahng	11	Ditto		
	Myaungmya	62	Ditto	Deputy Director, Irrawaddy Circle, Myaungmya.	
	Yudon	88	Ditto	Deputy Director, Tenasserim Circle, Moulmein.	
	Akyab	138	Ditto		
	Kyaukpyn	23	Ditto	Deputy Director, Arakan Circle, Akyab.	
	Paukkaung	16	Ditto	Entomologist, Mandalay.	
	Cuttack	150	Manager		
	Khurda	31	Overseer		
	Balasore	75	Ditto		
	Angul	47	Ditto	Assistant Director of Agriculture, in charge of Orissa Range.	
	Puri	42	Ditto		
	Kuljang	30	Ditto		
	Sepaya	379	Manager		
	Slvan	25	Overseer		
	Dharbanga	26	Ditto	Deputy Director of Agriculture, North Bihar Range.	
	Purnea	60	Assistant Director of Agriculture.		
	Lyreah (District Champaran)	316	Farm Manager	Manager, Bettiah Raj (Court of Ward's Farm).	
	Sabour	190	Assistant Director of Agriculture.		
	Monghyr * (Dairy farm)	200	Manager		
	Jamui	38	Overseer	Assistant Director of Agriculture, in charge of South East Bihar Range.	
	Banka	26	Ditto		
	Gaya	103	Manager	Deputy Director of Agriculture, in charge of South Bihar Range.	

*Of which 202 acres were presented by the Hon'ble Maharaja of Burdwan.

*Monghyr Dairy Farm abolished from August 1931.

Bihar and Orissa

List of Agricultural Stations in India in 1929-30 and 1930-31—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	REMARKS
Bihar and Orissa—contd.	Patna	200	Overseer	Deputy Director of Agriculture, in charge of South Bihar Range.	
	Navadaha	83	Ditto		
	Bikramganj	24	Ditto		
	Sirsi	35	Ditto		
	Kanke	340	Manager	Deputy Director of Agriculture, Chola Nagpur Range.	
	Natarhat	103	Overseer		
	Purnia	52	Ditto		
	Ramgarh	43	Ditto		
	Chhanki	32	Ditto		
	Sambalpur	32	Ditto	Economic Botanist, C. P.	
	Chalbassa	38	Ditto		
	Akola	272	Superintendent		
	Chhindwara	69	Ditto		
	Powarkhera	528	Ditto	Deputy Director of Agriculture.	
	Adhartal	209	Ditto		
	Nagpur	280	Ditto		
	Labhandi	229	Ditto		
	Tharan	110	Ditto	Principal, Agricultural College, Nagpur.	
	Basim	110	Ditto		
	Waraseoni	63*	Ditto		
	Betul	160	Ditto		
	Bilaspur	253	Ditto		
	Buldana	135	Ditto		

Demonstration Farm.
* Cropped area.

Central Provinces	Sindwahi	150*	Ditto	Deputy Director of Agriculture.	* Cropped area.
	Damoh	152	Ditto		
	Drug	281	Ditto		
	Khandwa	177	Ditto		
	Chandkhuri	110*	Ditto		* Cropped area.
	Saugor	101	Ditto		
	Seoni	170	Ditto		
	Yectmal	106	Ditto		
	Narsinghpur	87	Ditto		
	Drug	..	Ditto	Deputy Director of Agriculture in charge, Animal Husbandry.	Cattle-breeding Farm.
	Ellichpur	300	Ditto		(Attached to the Experimental Farm, Powarkhara.)
	Powarkhara	..	Ditto	Deputy Director of Agriculture.	Central Breeding Farm.
	Adhartal	339	Ditto		
	Telinkheri	1,000	Ditto	Deputy Director of Agriculture in charge, Animal Husbandry.	
	Chandkhuri	†	Ditto	Deputy Director of Agriculture.	
	Khandwa	†	Ditto		
	Garhi	1,223	Ditto		
	Bod	2,906	Ditto	Deputy Director of Agriculture in charge, Animal Husbandry.	
	Pendra	2,500	Ditto		
	Boregaon	378	Ditto	Deputy Director of Agriculture.	
	Blaspur	†	Ditto		
	Upper Shillong	300	Farm Manager	Live-stock and Dairy Expert, Assam.	Cattle breeding, potatoes and fodder crops.
	Khanapara	197	Ditto		Cattle and fodder crops.
Assam	Jorhat	59	Ditto	Deputy Director of Agriculture, Upper Assam Valley.	Sugarcane.
	Titabar	125	Ditto		Rice.
	Karimganj	80	Ditto	Deputy Director of Agriculture, Surma Valley.	Do.

† These farms are attached to the Demonstration Farms.

List of Agricultural Stations in India in 1929-30 and 1930-31—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	REMARKS
N.W. F. P.	Tarnab	200	Manager	Agricultural Officer, N.W. F. Province.	Main Farm. Cattle breeding opened in 1930-31.
	Harpur	20	Ditto		
	Himayatsagar, Hyderabad	290	Superintendent, Govern- ment Main Farm.	Deputy Director of Agriculture, Telangana.	
	Cattle-breeding Farm, Himayatsagar	600	Superintendent, Cattle- breeding Farm.		
	Nizamnagar (District Nizamabad)	0	Superintendent, Nizam- nagar.		
Hyderabad	Mahbubnagar	170	Superintendent, Mahbub- nagar Farm.	Deputy Director & Agriculture, Maharashtra.	Main Farm.
	Sangareddy	101	Superintendent, Sangareddy Farm.		
	Parbhani	204	Superintendent, Govern- ment Main Farm.	Deputy Director of Agriculture, Telangana.	
	Allr	63	Superintendent, Allr Farm		
	Agricultural Experimental Farm, Heb- bai, Bangalore.	74	Farm Manager	Economic Botanist.	
	Agricultural Experimental Farm, Bota- nical Section breeding plots.	..	Agricultural Inspector		
	Marthur Farm (Shimoga District)	62	Farm Manager	Deputy Director of Agriculture, Shimoga Circle.	
Mysore	Babbar Farm (Chitaldrug District)	218	Manager	Director of Agriculture in Mysore.	The Economic Botanist.
	Babbar Farm for Cotton, Jola and Coconut breeding.	..	Senior Assistant Botanist		
	Paddy-breeding Station, Negenhall, Mysore District.	65	Junior Assistant Botanist	The Economic Botanist.	
	Kar Hagli-breeding Station, Hunsur, Mysore District.	42	Ditto		

Baroda	Coffee Experimental Station, Balchonnur, Katur District.	200*	Manager	Deputy Director of Agriculture, Chikmagalur Circle.
	Cattle-breeding Station (Main and Sub-Stations), Aljampur, Katur District.	5,630†	Manager, Main Station	} Live-stock Expert.
	Yelachihalli Sheep Farm	400	Manager, Sub-Station	
	Mysore Irwin Canal Farm	600†	Agricultural Inspector	} Agricultural Chemist on Soil Surveys.
	Agricultural Experimental Station, Baroda.	84	Superintendent	
	Agricultural Experimental Station, Jagudan.	17-6	Ditto	} Deputy Director of Agriculture for Baroda District.
	Agricultural Experimental Station, Anrell.	30-4	Ditto	
	Fruit Farm, Cape Comorin	16	Agricultural Inspector	} Director of Agriculture.
	Paddy Farm, Nagereoli	40	Ditto	
	Cattle-breeding Farm, Lasanthman-galam.	7	Veterinary Inspector	} Director of Agriculture and Fisheries.
Travancore	Demonstration Farm, Eraniel	17	Agricultural Sub-Inspector	
	Cattle Farm, Trivandrum	100	Agricultural Inspector	} Agricultural Inspector.
	Experimental Farm, Karamanal	100	Ditto	
	Experimental Farm, Kottarakara	100	Agricultural Sub-Inspector	} Director of Agriculture and Fisheries.
	Pepper Farm, Koni	150	Agricultural Inspector	
	Demonstration Farm, Pullyara	40	Ditto	} Agricultural Inspector.
	Coconut Farm, Oachira	4	Agricultural Demonstrator.	
	Coconut Farm, Chettikulangara	5	Ditto	} Agricultural Inspector.
	Coconut Farm, Allippee	9	Ditto	
	Coconut Farm, Valkom	5	Agricultural Inspector	} Director of Agriculture and Fisheries.
	Green Manure Farm, Vengola	5	Agricultural Sub-Inspector	
	Demonstration Farm, Alwaye	13	Head Master, Agricultural School, Alwaye.	

* Of this 82 acres are under coffee, 20-25 years old. 25 acres have been planted with selections from high yielding mother trees from estates throughout S. India.
† A combined experimental demonstration and seed farm for the Irwin Canal tract (opened in 1920-31).

List of Agricultural Stations in India in 1929-30 and 1930-31—concl.

Province	Agricultural Station	Aren in acres	Officer in immediate charge	Supervising Officer	REMARKS
Gwalior State	Gwalior	205	Farm Manager	Deputy Administrative Officer, Agricultural Section, Gwalior Division, Gwalior.	
	Ujjain	240	Ditto	Deputy Administrative Officer, Agricultural Section, Malwa Division, Ujjain.	
Bhopal	Nabi Begi	170	Assistant Director of Agri- culture.	Director of Agriculture.	Principal Farm.
	Xoraiat Afza	41	Ditto		
	Xisaiat Afza	5	Ditto		
	Int-Kheri	70	Ditto		Sugarcane Research Station. Sugarcane Farm.
Patiala	Bhupindra Agricultural Farm, Patiala	100	..	Ditto.	

APPENDIX III.

Staffs of Provincial and State Departments of Agriculture in India during 1929-30 and 1930-31.

Province.	RESEARCH AND TEACHING STAFF									
	SUPERIOR SERVICE			PROVINCIAL SERVICE			SUBORDINATE SERVICE			
	Sanctioned cadre		Filled substantively	Sanctioned cadre		Filled substantively	Sanctioned cadre		Filled substantively	
	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31
(a) British India.										
Madras	8	6	7	21	21	20	116	115	104	111
Bombay	6	6	6	15	15	15	29	28	28	24
Bengal	6	7	6	5	4	5	34	38	34	38
United Provinces	8	8	7†	10‡	11	9	45	45	45	45
Punjab	18 (a)	17 (b)	17 (a)	15 (d)	15 (b)	15 (d)	58	64	53	64
Burma	4	4	3	11	9	9	18	18	13	13
Bihar and Orissa	2	3	..	4	3	4	3	3	3	3
Central Provinces	2	2	2	9	10	6	17	22	17	22
Assam	2	2	2	..	..	..	10	11	10	11
North-West Frontier Province	1	1	..	1	..	1	2	6	..	5
† Includes 5 I. A. S. posts and 2 U. P. A. S.—posts replacing I. A. S. post held in abeyance										
‡ Includes one temporary.										
(d) 1 temporary.										
(e) Includes 13 temporary.										
(b) Indian States.										
Hyderabad	1	1	1	1	1	1	4	4	4	4
Mysore	1	1	1	10	10	10	88	88	88	88
Baroda	..	1	..	..	2	1	..	3	..	3
Travancore	1	1	1	6	6	2	4	12	4	12

APPENDIX III—contd.
Staffs of Provincial and State Departments of Agriculture in India during 1929-30 and 1930-31—contd.

Province.	DISTRICT STAFF									
	SUPERIOR SERVICE				PROVINCIAL SERVICE				SEMI-PRIVATE SERVICE	
	Sanctioned cadre		Filled substantively		Sanctioned cadre		Filled substantively		Sanctioned cadre	
	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31
(a) British India.										
Madras	7	8	7	8	17	18	10	17	237	250
Bombay	9	0	0	8	8	8	8	8	275	275
Bengal	3	4*	1	2*	5	8*	4	7*	103	203*
United Provinces	12	12	0†	0	10	17	10	17	131	131
Punjab	10 (h)	10 (h)	0 (c)	0 (h)	23 (c)	23 (h)	23 (c)	22 (h)	592 (f)	590 (g)
Burma	11	11	7	7	21	21	7	7	84	80
Bihar and Orissa	8	7	4	3	11	12	11	12	110	93
Central Provinces	8	8	7	0	13	12	11	10	125	124
Assam	3	3	3	2	3	3	3	3	17	17
North-West Frontier Province	..	1	..	1	..	1	..	1	0	8
(b) Indian States.										
Hyderabad	3	3	3	3	5.	5	5	5	25	25
Mysore	..	..	..	..	..	17	..	17	..	..
Kanara	..	..	..	..	..	6	..	6	..	..
Travancore	..	..	..	..	7	3	7	3	6	4

* Includes sericulture staff also.

† Includes one temporary.

(g) 21 temporary.

(b) Includes temporary staff.
(h) 2 temporary.

(c) 1 temporary.

(e) 1 temporary.

(f) 111 1/2 temporary.

APPENDIX IV.

Showing results of well-boring in India during 1929-30 and 1930-31.

Province.	1928-29		1929-30		1930-31	
	Number of bores	Number successful	Number of bores	Number successful	Number of bores	Number successful
(a) British India.						
Madras	746	478	549	376	337	228
Bombay	254	149	312	182	68	39
Bengal	130	122	212	210	39	38
United Provinces	1,552	1,227	1,543	1,137	1,402	1,070
Punjab	906	774	935	786	897	696
Bihar and Orissa	303	287	289	238	222	197
	3,951	3,032	3,840	2,929	2,955	2,258
(b) Indian States.						
Hyderabad	58	52	53	44	65	56
Mysore	18	16	24	18	....	....
Baroda	32	18	59	39	32	26
Patiala	22	20	....	....	11	8

APPENDIX V.

Showing sale of improved implements through departmental agency in India during 1929-30 and 1930-31.

Province	PLOWERS		CANE MILLS			FODDER CUTTERS			
	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31
(a) British India.									
Madras	2,045	1,235	753	25	64	11	20	20	36
Bombay Presidency proper	397*	546	255	15*	31	25	0*	9	..
Sind	..	499	671	..	..	..	..	7	..
Bengal	47	51	43	..	4	2	..	1	2
United Provinces	5,049	5,954	4,954	130	298	217	58	155	137
Punjab	7,510	8,880	9,434	915	2,647	4,906	7,142	14,258	12,570
Burma	4,463	6,784	6,137	15	16	0	2	5	13
Bihar and Orissa	324	802	565	24	36	320	0	4	4
Central Provinces	7,613	5,639	2,700	102	129	112	98	45	38
Assam	5	..	..	108	77	97	..	..	..
N.-W. F. P.	5	..	1	..	..	..	..	..	..
TOTAL	27,478	80,390	25,513	1,304	3,302	5,792	7,841	14,610	12,800
(b) Indian States.									
Hyderabad	..	70	77	..	1	1	..	6	1
Mysore	1,791†	2,692	1,550	30†	109	47	..	..	..
Travancore	705	343	8	..	..	..	..	..	..
Baroda	66	35	27	..	..	..	..	3	1

* Includes Sind.

† Revised

APPENDIX V—*contd.*

Showing sale of improved implements through departmental agency in India during 1929-30 and 1930-31—contd.

Province	HOES			OTHER IMPLEMENTS				SPARE PARTS		
	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31	
(a) British India.										
Madras	10	30	3	511	445	330	3,967	2,020	1,230	
Bombay Presidency proper	20*	36	31	715*	319	346	204*	184	316	
Sind	..	3	..	..	137	76	..	100	626
Bengal	13	2	3	4	2	1	9	5	6	
United Provinces	40	20	36	199	337	463	8,242	10,939	8,648	
Punjab	125	163	366	2,435	2,141	2,443	4,891	9,363	4,008	
Burma	5	55	38	146	40	186	967	1,000	661	
Bihar and Orissa	..	18	3	16	54	76	2	..	256	
Central Provinces	99	132	402	877	1,207	974	11,494	17,116	14,324	
Assam	..	5	1	50	40	44	60	34	41	
North-West Frontier Province	..	..	1	2	..	..	12	..	4
TOTAL	330	473	940	4,985	4,790	4,944	29,848	40,761	20,129	
(b) Indian States.										
Hyderabad	..	1	33	..	13	..	..	..	3
Mysore	164†	325	107	23†	04	403	4,129†	7,810	4,104	
Travancore	..	..	..	..	..	..	..	..	..
Baroda	..	2	..	..	..	1	..	..	..

* Includes Sind.

† Revised.

APPEN

Improved seeds and manures distributed

Province	SEED DIS					
	SEED GRAIN IN CWT.			NO. OF WHOLE CANES EXCEPT WHERE OTHERWISE STATED		
	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31

(a) British

Madras	17,071	11,823	10,434	72,515 12,550 setts	451,024	2,314,223
Bombay Presidency proper . .	*25,324	10,530	25,371	*64,000	64,101	203,940
Sind . . . . .	..	3,720	4,018	..	cwts. ⁵	cwts. ⁰
Bengal	4,088	3,435	8,885	2,237,268	661,861	1,405,305
United Provinces	92,905	60,182	132,822	201,523 cwts.	360,848	646,472 cwts.
Punjab	62,509	†	40,140	†	†	†
Burma	62,660	63,000	86,400	82,410	65,825	450,540
Bihar and Orissa	1,435	4,000	3,435	28,510 cwts.	1,713,032	610,351
Central Provinces	322,472	433,230	362,542	803,273	2,846,844	1,081,312
Assam	580	2,061	1,750	53,012	341,690 setts	278,320
North-West Frontier Province .	223	..	170	25 cwts.	..	3-57 cwts.
TOTAL	500,240	634,024	685,885	..	..	..

(b) Indian

Hyderabad . . . . .	..	34,620	20,378	..	..	564 cwts.
Mysore	1,110	1,027	3,401	2,019,030	2,014,888	2,062,894
Bareilly	3,100	230	704	..	4,200	..
Travancore	312	312	233	..	..	..
Bhopal	130	..	..	128,300	..	..
Patiala	193	..	658	..	..	68 cwts.

* Including Sind.

† Not available.

AGRICULTURAL OPERATIONS IN INDIA, 1929-30 AND 1930-31 287

DIX VI.

through departmental agency in India during 1929-30 and 1930-31.

TRIBUTED			MANURES DISTRIBUTED					
FRUIT PLANTS No.			COMMERCIAL FERTILIZERS IN CWT.			OIL CAKES IN CWT.		
1928-29	1929-30	1930-31	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31

India.

100,440	740,008	30,031	101,105	31,184	†	34,040	8,805	†
*24,020	24,500	31,034	4,801	6,018	9,170	129	389	376
--	017	501	--	13	3	--	--	--
167	390	100	653	311	350	89	89	183
15,300	19,859	15,599	2,281	9,012	9,528	11,525	13,321	22,729
†	†	(a) 5,050	†	†	†	†	†	†
817	1,247	1,896	66	303	2,325	--	362	--
1,200	758	554	5,220	13,269	7,058	--	--	--
5,900	2,983	5,010	1,030	1,003	1,882	472	437	562
4,908	4,327	7,002	4,503	1,841	1,375	101	38	97
17,500	17,000	20,000	--	--	24	--	--	--
231,034	800,529	128,957	181,475	65,747	31,715	47,205	23,531	23,897

States.

--	--	--	--	273	42	--	9	353
11,181	21,582	9,300	15,920	2,730	3,800	310	60	237
1,229	4,032	2,039	131	173	160	--	--	--
3,820 Rs. worth	--	--	507	300	170	--	--	--
--	--	--	100	--	--	--	--	--
--	--	270	--	--	--	--	--	--

* Including Sind.

† Not available.

(a) Nursery plants

4,400

† Not distributed through departmental agency in this province.

Cuttings

1,250

5,650

APPENDIX VII.

Demonstration and propaganda work in India during 1929-30 and 1930-31.

Province	NUMBER OF AGRICULTURAL SHOWS HELD			NUMBER OF PRACTICAL DEMONSTRATIONS CARRIED OUT			NUMBER OF ILLUSTRATED PICTURES GIVEN		
	1929-29	1929-30	1930-31	1929-29	1930-30	1930-31	1929-29	1930-30	1930-31
(a) British India.									
Madras	252	255	153	7,060	6,203	7,048	305	541	450
Bombay Presidency proper	38*	37	20	1,167*	1,468	1,610	176*	208	186
Sind	..	1	5	..	247	428	..	12	6
Bengal	35	33	38	2,613	2,427	2,861	130	115	177
United Provinces	80	63	112	26,453	23,664	18,846	642	277	385
Punjab (e).	..	..	..	..	..	..	..	..	..
Burma	32	32	23	842	1,017	1,182	102	246	204
Bihar and Orissa	7	17	15	3,603	5,083	7,037	1	30	4
Central Provinces	38	38	23	4,040	4,371	4,200	160	285	343
Assam	6	5	5	1,703	1,538	1,953	25	37	73
North-West Frontier Province	..	..	..	..	..	..	..	..	..
TOTAL	407	511	403	47,481	46,108	46,065	1,541	1,761	1,787
(b) Indian States.									
Hyderabad	..	1	4	..	204	415	..	17	23
Mysore	4	..	40	814	075	1,638	..	..	104
Baroda	..	3	2	..	1	..	..	..	..
Travancore	4	4	5	350	..	..	..	..	..
Patiala	17	..	17	31	..	766	..	..	..

* Including Sind.
(e) Figures not available.

APPENDIX VIII.

**Agricultural Colleges and Schools in India during 1929-30
and 1930-31.**

APPENDIX

Agricultural Colleges and Schools

Name of college or school	Courses of instruction	1928-29			
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination

(a) BRITISH

(i) Post graduate

Agricultural Research Institute, Pusa.	(1) Two-year Post-graduate Course.	26	0	11	2
	(2) One year Post-graduate course in farm management and organization and general farm-engineering.	..	..	..	..
	Special courses . . .	..	..	..	..
Imperial Institute of Animal Husbandry and Dairying, Bangalore.	Fifteen-month Post-graduate Course.	..	3	7	4
	Twenty-four-month Course.	..	..	1	..
	Two-year Indian Dairy Diploma Course.	..	4	31	3
Imperial Cane Breeding Station, Coimbatore.	Short Course . . .	21	21	21	10
	No regular course, but facilities given to study the methods of cane breeding.	5	5	5	..

(ii) Provincial Agri

Agricultural College, Coimbatore.	Three-year B. Sc. Ag. Degree Course.	307	41	121	10
Agricultural College, Poona.	Three-year B. Ag. Degree Course.	187	75	216	60
	College Diploma Course .	..	..	..	4
Agricultural College, Cawnpore.	Four-year L. Ag. Diploma Course in 1929-30 and B. Sc. Degree (in 1930-31).	182	50	131	8
	Two-year Certificate Course.	113	30	46	13
	Four-year B. Sc. Ag. Degree Course.	412§	44	253	28
Punjab Agricultural College, Lyallpur.	One-and-a-half year M. Sc. Degree Course.	7	4	6	1
	Two-year certificate Course.	..	..	18	15
	Six-month Vernacular Course (Summer Class).	231	38	38	37
	Six-month Vernacular Course (Winter class).	171	41	41	39
	One-month Rural Economy Course.	21	21	21	21
	Ten-and-a-half-month Teachers' Training Course.	50	35	31	28
	Six-week Blacksmith Class.	30	17	17	17

AGRICULTURAL OPERATIONS IN INDIA, 1929-30 AND 1930-31 291

VIII.

in India during 1929-30 and 1930-31.

1929-30				1930-31				REMARKS
Applica- tions for admis- sion	Admis- sions made during the year	Total number on the roll	Number passed in final examina- tion	Applica- tions for admis- sion	Admis- sions made during the year	Total number on the roll	Number passed in final examina- tion	

INDIA.

Training Institutions.

30	0	14	3	30	5	10*	5	*One left after 9 months.
..	2	2†	..	..	2	3	1	†One left after 5 months.
..	2	4	3	..	..	1	1	‡One left without completing the course.
0	5	0	4	5	3	8‡	5	
..	
04	24	01	22	..	..	24	..	
54	54	54	54	8	8	8	8	
1	1	3	3	1	1	1	1	

cultural Colleges.

303	40	125	33	‡Total number of applications received for admission to Leaving Certificate and Degree Course.
100	80	235	52	130	80	210	54	
..	..	..	1	..	..	..	3
270	47	150	27	155	42	152	32	
81	18	30	10	81	21	32	10	
274§	05	52	34	110	40	204	57	
..	..	3	..	1	1	4	3	
..	..	8	8	..	..	..	..
||	32	32	2	||	32	27	21	
||	39	39	32	||	34	31	28	
23	23	22	22	23	23	23	23	
43	30	27	25	44	28	25	23	
27	25	14	0	27	13	13	13	

|| Applications for admission were received by respective D. D. A.'s and selection was made by them.

Agricultural Colleges and Schools

Name of College or School		Courses of Instruction	1928-29.				
			Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	
(ii) Provincial Agri							
Agricultural Mandalay.	College,	Three-year Course.	Diploma	60	22	43	10
Agricultural Nagpur.	College,	Four-year Degree Course	College	91	51	40	5
		Four-year Diploma Course.					3
(iii) Agricul							
<i>Madras.</i>							
Agricultural Middle School, Taliparamba.		Two-year Course	.	40	19	44	17
<i>Bombay.</i>							
Vernacular Agricultural School, Lonl.		Ditto	.	93	18	39	15
Vernacular Agricultural School, Dowlhosur.		Ditto	.	68	12	27	13
Vernacular Agricultural School, Jambur.		Ditto	.	10	8	20	8
Vernacular Agricultural School, Godhra.		Ditto	.	47	18	18	16
Vernacular Agricultural School, Dhulla.		Ditto	.	49	17	31	13
Vernacular Agricultural School, Surat.		Ditto	.	87	15	31	31
<i>Bengal.</i>							
Secondary Agricultural School, Dacca.		Two-year Course for regular students and one-year Course for Demonstrators.		27	20	29	3
<i>United Provinces.</i>							
Vernacular Agricultural School, Bulandshahr.	{	(1) Two-year Vernacular Course.		90	36	33	28
		(2) Teachers' Training Class.		12	12	12	13
		(3) Fieldmen's Course	.	--	--	--	--
		(4) Engine Drivers' Course.		10	10	10	5
		(5) Garden Overseers' Course.		12	10	10	--
<i>Punjab.</i>							
Agricultural Vernacular Class, Gurdaspur.	{	Six-month Vernacular Course (Summer Class).		75	30	30	30
		Six-month Vernacular Course (Winter Class).		100	32	32	32

in India during 1929-30 and 1930-31—contd.

1929-30				1930-31				REMARKS
Applica- tions for admis- sion	Admis- sions made during the year	Total number on the roll	Number passed in final examina- tion	Applica- tions for admis- sion	Admis- sions made during the year	Total number on the roll	Number passed in final examina- tion	

cultural Colleges—contd.

77	10	34	8	77	23	33	18
137	48	115	10	132	34	126	9

tural Schools.

41	17	23	14	..	..	..	..
73	25	37	18	58	23	35	10
51	21	32	13	128	24	37	13
24	31	20	7	20	20	30	10
30	0	15	14	21	17	27	8
50	16	31	15	81	17	32	15
19	13	25	21	22	16	20	10
74	32	59	27	58	27	52	28
80	37	66	32	91	37	64	20
43	43	43	12	33	33	33	43
5	5	5	5	8	8	8	5
18	10	10	0	25	10	10	9
10	10	0	0	10	1	1	1
42	37	51	31	37	25	22	22
40	27	25	25	23	12	10	10

Agricultural Colleges and Schools

Name of College or School	Courses of Instruction	1928-29			
		Applica- tions for admis- sion	Admis- sions made during the year	Total number on the roll	Number passed in final examina- tion

(iii) *Agricultural*

Agricultural Vernacular Class, Hansi.	Six-month Vernacular Course (Summer Class).	70	35	21	15
	Six-month Vernacular Course (Winter Class).	50	38	23	10
<i>Burma.</i>					
Agricultural School, Pyinmana.	Four-year Course . . .	..	54	65	9
	Two-year Course . . .				
Central Farm School, Hmawbi.	Short-course of practical training for 9 months.	..	10	10	6
	Short-course of practical instruction.	..	35	35	35
Central Farm School, Mahlaing.	Short-course of practical training for 10½ months.	..	12	7	7
Central Farm School, Mudon.	Short-courses of practical instruction.	..	..	..	..
Central Farm School, Tatkon.	Ditto . . .	..	21	21	21
Central Farm School, Padu.	Ditto . . .	..	14	12	12
Central Farm School, Ailamyo.	Ditto . . .	..	50	50	50
	For one-year . . .	..	..	..	..
<i>Central Provinces.</i>					
Agricultural Middle School, Powarkhera.	Four-year Course . . .	52	35	82	10

(b) *Indian*

<i>Mysore State.</i>					
Agricultural School, Hebbal	Three-year Course in English leading to an I. Ag. Diploma.	68	26	44	7
Vernacular Agricultural School, Chikkannahalli.	One-year Course . . .	75	15	15	15
Vernacular Agricultural School, Hassan.	Ditto . . .	22	15	11	**
Vernacular Agricultural School, Ramakrishna-krishnala.	Ditto . . .	..	15	15	**
<i>Baroda State.</i>					
Agricultural School, Baroda	One-year Course . . .	33	15	13	11
<i>Travancore.</i>					
Agricultural School, Alwaye	Two-year Course . . .	25	16	16	12
Agricultural School, Kottara-Kara.	Ditto . . .	95	20	39	22
Agricultural School, Konl .	Ditto . . .	..	..	..	..
<i>Patiala State.</i>					
Bhupindra Agricultural School, Patiala.	Two year Course . . .	10	19	11	**

** Examination not held.

AGRICULTURAL OPERATIONS IN INDIA, 1929-30 AND 1930-31 295

in India during 1929-30 and 1930-31—contd.

1929-30				1930-31				REMARKS.
Applica- tions for admis- sion	Admis- sions made during the year	Total number on the roll	Number passed in final examina- tion	Applica- tions for admis- sion	Admis- sions made during the year	Total number on the roll	Number passed in final examina- tion	

tural Schools—contd.

81	15	14	13	49	13	8	8	
72	21	16	10	47	14	10	9	
..	42	54	70	..	43	70	12	
..	10	..	9	..	10	9	8	
..	64	..	61	..	27	..	27	
..	32	..	10	..	47	11	11	
..	10	..	10	..	14	..	7	
..	3	..	3	..	4	2	4	
..	3	..	1	..	14	14	14	
..	106	..	106	..	53	..	..
..	6	..	1	..	10	..	..
69	40	101	16	48	31	89	13	

States.

96	28	59	5	102	30	72	12	
86	17	17	15	65	18	18	17	
30	17	11	11	21	17	11	8	
59	14	14	13	33	15	16	14	
59	15	10	10	51	15	9	9	
..	..	..	..	61	19	17	..	The last ad- mission was in 1928.
..	..	..	..	62	32	29	..	Ditto.
..	..	..	..	133	52	52	..	Opened in 1931.
20	10	10	8	28	18	11	..	

APPENDIX IX.

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1929-31.

The two tables below include Agricultural Societies for—

- A. 1. *Purchase and Purchase and Sale.*—These are societies intended to facilitate the purchase of agricultural requisites for members, such as societies which purchase seed, manure, implements, etc., for sale to their members. Societies of this character which collect for joint sale the produce of members without making this their main object are also included in this class.
2. *Production.*—These are societies which have for their chief object an act of production without proposing to themselves sale as a direct object. These also include societies for joint irrigation, for collective use of machinery, for assistance in horse and cattle breeding, etc.
3. *Production and sale.*—This class includes societies in which these two functions are united or in which one or the other predominates, it being impossible to make a clear distinction between them. It covers all societies whose main object is the joint sale of any commodity, whether such commodity is produced or worked up or prepared for sale by the society itself or by the members individually. It comprises all co-operative creameries and distilleries, as well as societies whose main object is the sale of grain, cattle, eggs, *ghi*, etc., produced by their members.
4. Other forms of co-operation except insurance.

B. Insurance.

APPENDIX IX---contd.

Operations of Non-credit Agricultural Co-operative Societies in India during 1929-30 and 1930-31.

(A) PURCHASE, SALE AND PRODUCTION.

Province	Class of Societies	1929-30						REMARKS
		Number of Societies	Number of Members	Sale of goods to Members	Purchase of members' products	Working Capital	Profit and loss for the year	
Madras	Purchase and purchase and sale.	128	12,893	Rs. 23,38,018	Rs. 5,48,629	Rs. 6,98,937	Rs. —4,859	
	Production and sale . .	42	2,047	..	..	1,75,089	—28,914	
	Others	391	24,032	..	..	4,20,592	—6,661	
	TOTAL .	561	38,972	23,38,018	5,48,629	12,94,618	—40,434	
Bombay	Purchase and purchase and sale.	51	3,418	25,655	6,017	4,15,989	—7,552	
	Production	17	593	..	..	11,760	—318	
	Production and sale . .	81	15,142	9,98,901	3,62,621	15,08,461	+53,199	
	Others	104	69,146	61,515	10,652	3,39,331	+86,632	
	TOTAL .	253	78,299	10,86,071	3,79,290	22,75,541	+1,31,961	

Operations of Non-credit Agricultural Co-operative Societies in India during 1929-30 and 1930-31—contd.

(A) PURCHASE, SALE AND PRODUCTION—contd.

Province	Class of Societies	1929-30						Profit and loss for the year	REMARKS
		Number of Societies	Number of Members	Sale of goods to Members	Purchase of Members' Products	Working Capital			
Bengal	Purchase and purchase and sale.	108	31,606	77,13,193	79,94,917	48,26,012	Rs.	Rs.	
	Production . . .	887	22,626	65	..	4,25,687			—12,91,236
	Production and sale . .	245	12,389	3,85,687	4,55,799	8,52,109			—14,203
	Others . . .	40	9,665	10,086	817	1,11,142			+1,22,873
	TOTAL	1,280	76,286	81,09,031	84,51,533	62,14,950			—50
United Provinces	Production and sale . .	23	454	..	19,939	261			—11,82,616
	Others . . .	117	3,722	..	..	1,682			+467
	TOTAL	140	4,176	..	19,939	1,943			+845
	Purchase and purchase and sale.	17	1,231	1,01,172	92,714	55,463			+1,312
Punjab	Production . . .	180	4,574	..	2	3,617			+3,631
	Production and sale . .	805	42,640	27,05,463	33,57,434	7,33,200			+786
	Others . . .	83	1,533	..	..	68,073			+23,823
	TOTAL	1,085	49,978	28,06,635	34,50,150	8,60,353			+4,563
	TOTAL	1,085	49,978	28,06,635	34,50,150	8,60,353			+32,803

AGRICULTURAL OPERATIONS IN INDIA, 1929-30 AND 1930-31 299

	3	463	2,863	10,495	37,403	+16
Burma.						
Purchase and purchase and sale.						
Production . . .	5	50	..	..	..	..
Production and sale . .	18	1,871	4,440	..	2,06,057	-75,418
TOTAL	26	2,383	7,103	10,495	2,43,460	-75,402
Bihar and Orissa.						
Purchase and purchase and sale.	3	268	..	4,010	2,265	-411
Production . . .	3	153	..	..	5,674	..
Production and sale . .	2	91	3	6	11,075	-49
Others . . .	5	212	..	..	426	+65
Grain <i>Golas</i> . . .	72	22,004	..	..	(a) 2,58,636	(b) +9,224
TOTAL	85	22,728	3	4,016	(a) 2,78,076	(b) +8,829
Central Provinces.						
Purchase and purchase and sale.	26	1,399	3,04,817	..	1,34,495	+16,815
Production . . .	4	43	..	100	456	..
Production and sale . .	7	775	21,370	..	83,964	+3,624
TOTAL	37	2,217	3,26,187	100	2,18,915	+20,439
Assam						
Production and sale . .	2	131	..	17,120	10,525	+3,656
TOTAL	2	131	..	17,120	10,525	+3,656

Operations of Non-credit Agricultural Co-operative Societies in India during 1929-30 and 1930-31—contd.

(A) PURCHASE, SALE AND PRODUCTION—contd.

Province	Class of Societies	Number of Societies	Number of Members	Sale of goods to Members	Purchase of Members' Products	Working Capital	Profit and loss for the year	REMARKS
1929-30								
Delhi . . .	Cattle breeding . . .	1	65	..	..	..	..
	Consolidation of holdings . .	2	145	..	..	..	..
	TOTAL	3	210	..	..	..	..
	Purchase and sale . . .	..	..	..	..	..	..
Baroda State	Production . . .	..	..	..	..	..	..
	Production and sale . . .	..	..	..	..	..	..
	TOTAL	..	..	..	..	..	..
	Purchase and purchase and sale	52	1,604	1,25,695	71,810	1,39,081	+5,417	
Mysore . . .	Production . . .	1	11	..	..	3,738	..	
	Production and sale . . .	19	305	1,081	858	13,973	+393	
	TOTAL	72	1,880	1,26,776	72,668	156,792	+5,810	

AGRICULTURAL OPERATIONS IN INDIA, 1929-30 AND 1930-31 301

1930-31

	Purchase and purchase and sale.		12,014	3,38,019	4,32,138	4,53,475	-21,589
Madras	Production and sale	.	1,791	..	..	1,61,705	-20,199
	Others	392	24,053	708	..	4,06,003	-10,584
	TOTAL	511	38,758	3,38,787	4,32,138	10,81,243	-61,332
	Purchase and purchase and sale.	44	3,918	20,991	10,932	3,75,143	-5,553
Bombay	Production	10	579	160	138	9,629	+134
	Production and sale	74	15,107	6,22,791	8,37,360	14,86,852	+90,814
	Others	105	51,254	52,204	1,242	4,70,578	+22,080
	TOTAL	239	70,918	7,05,206	8,58,672	23,42,202	+1,08,055
	Purchase and purchase and sale.	95	12,935	5,37,722	4,74,823	7,13,271	-65,586
Bengal	Production	929	23,747	227	18,385	4,49,805	-16,293
	Production and sale	207	13,331	3,74,718	7,04,962	9,76,001	-75,714
	Others	43	9,632	5,919	1,423	1,66,017	+3,491
	TOTAL	1,334	59,545	9,18,586	12,50,583	23,04,894	-1,54,102
United Provinces	Production and sale	31	805	44,923	49,811	8,426	+239
	Others	219	5,312	..	..	2,777	+497
	TOTAL	250	6,117	44,923	49,811	11,203	+736

Operations of Non-credit Agricultural Co-operative Societies in India during 1929-30 and 1930-31—contd.

(A) PURCHASE, SALE AND PRODUCTION—contd.

Province	Class of Societies	Number of Societies	Number of Members	Sale of goods to Members	Purchase of members' products	Working Capital	Profit and loss for the year	REMARKS.
1930-31								
Punjab	Purchase and purchase and sale.	18	1,489	Rs. 1,16,510	Rs. 1,04,998	Rs. 69,633	Rs. —408	
	Production . . .	172	4,537	..	223	6,225	+346	
	Production and sale . . .	954	55,295	22,35,271	24,14,910	7,19,035	+9,115	
	Others . . .	88	1,670	..	..	72,700	+6,038	
	Total . . .	1,232	62,991	23,51,781	25,20,131	8,67,593	+15,091	
Burma.	Purchase and purchase and sale.	12	823	..	219	57,338	—1,022	
	Production . . .	5	50	..	..	..	..
	Production and sale . . .	15	1,586	2,576	..	1,96,670	—69,833	
	Total . . .	32	2,459	2,576	219	2,34,008	—79,855	
Bihar and Orissa . . .	Purchase and purchase and sale.	3	271	313	..	2,673	—465	
	Production . . .	3	161	..	..	8,009	—43	
	Production and sale . . .	2	59	..	976	11,946	—332	

AGRICULTURAL OPERATIONS IN INDIA, 1929-30 AND 1930-31 303

	Others	5	248	..	..	1,378	+91	(c) 128,257 mds. of grain.
	Grain <i>Golas</i>	68	20,552	..	..	(c) 2,04,419	+2,358(d)	
	TOTAL	81	21,291	313	976	2,28,425	+1,009	(d) 21,308 mds. of grain.
Central Provinces	Purchase and purchase and sale.	30	1,413	69,081	..	2,47,791	+6,176	
	Production	4	44	..	..	456	..	
	Production and sale	8	832	6,162	..	50,291	+2,367	
	TOTAL	42	2,239	75,243	..	2,98,538	+8,543	
Assam	Production and sale	..	..	..	..	..	..
	TOTAL	..	..	..	..	..	..
Delhi	Cattle breeding	1	68	..	..	..	..
	Consolidation of holdings	3	272	..	..	..	..
	TOTAL	4	340	..	..	..	..
Baroda State	Purchase and sale	21	689	22,484	1,076	6,804	664	
	Production	21	556	449	2,870	36,342	1,121	
	Production and sale	35	1,333	7,46,508	15,337	19,078	1,184	
Mysore	TOTAL	77	2,558	7,69,441	19,283	62,224	2,969	
	Purchase and purchase and sale.	49	1,449	18,839	553	1,54,123	+2,815	
	Production	1	13	..	..	3,612	..	Not working.
	Production and sale	18	380	2,552	1,766	14,371	+1,570	
	TOTAL	68	1,842	21,391	2,319	1,72,106	4,385	

Operations of Non-credit Agricultural Co-operative Societies in India during 1929-30 and 1930-31—contd.

(B) CATTLE INSURANCE.

Provinces	Number of societies	Amount of risk insured	Premia collected during the year	Supplementary contributions collected	NUMBER OF ANIMALS		Claims paid	Cost of management	Funds in hand at the end of the year	Amount of risk re-insured	Amount of premia paid for re-insurance
					Insured	Lost					
		Rs.	Rs.	Rs.			Rs.	Rs.	Rs.	Rs.	Rs.
1929-30											
Bombay . . .	3	5,025	251	..	78	5	154	70	1,439	..	..
Madras . . .	5	..	..	..	..	..	..	..	61	..	..
Burma . . .	257 1*	6,695 11,535	150 130	..	129 234	3 6	108 62	78 795	20,711 15,540	3,347 ..	75 ..
1930-31											
Bombay . . .	1	4,370	219	..	73	7	313	109	989	..	..
Madras . . .	5	..	..	..	..	..	..	..	61	..	..
Burma . . .	..	..	..	..	..	..	..	..	..	..	..

* Central Re-insurance Society.

APPENDIX X.

Showing the working of the Veterinary Departments in India during 1929-30 and 1930-31.

1020-30

Province	REPORTED MORTALITY FROM CONTAGIOUS DISEASES			DISPENSARIES AND HOSPITALS.			DISTRICT WORK						
	Rinderpest	Other diseases	Total	Number of institutions	Cases treated	Castrations performed	Cases treated	Castrations performed	Outbreaks in which inoculation was undertaken	Deaths un inoculated	Inoculations*	Deaths after inoculation	
	(c) British India.												
Madras	106,046	52,000	158,046	115	157,610	0,540	54,420	6,103	1,010	44,818	106,007	761	
Bombay	14,892	0,200	24,152	100	207,083	10,131	66,043	9,152	1,110	13,482	157,140	244	
Bengal	10,183	5,750	16,033	46	70,358	00	120,310	00	715	9,023	144,730	792	
United Provinces	35,845	12,480	48,331	165	295,840	2,878	100,888	309	1,777	21,640	220,780	201	
Punjab	10,031	13,051	24,282	270	1,000,510	185,177	304,212	170,014	1,062	7,823	470,400	187	
Burma	6,472	2,855	9,327	5	15,458	10	105,305	70	528	4,095	72,038	726	
Bihar and Orissa	27,212	8,489	35,604	33	74,135	7,553	113,163	04,374	1,786	12,075	324,032	1,250	
Central Provinces	30,622	10,010	40,632	90	292,385	7,024	407,058	81,820	2,684	17,764	374,004	280	
Assam	20,536	13,452	33,988	3	4,307	117	80,657	7,102	504	18,595	42,331	785	
North-West Frontier Provinces	520	962	1,488	10	73,853	13,142	40,773	25,054	44	545	11,378	12	
Sind	2,588	6,623	9,211	18	28,004	1,157	5,093	306	92	11,146	5,143	27	
Baluchistan	4	13,316	13,320	10	21,348	115	67,932	15	3	147	515	..	
Rajputana	047	118	705	2	3,532	13	83	..	0	250	741	1	
TOTAL	271,604	140,574	421,178	801	2,320,085	243,562	1,450,008	353,428	12,107	103,530	2,020,520	5,314	
TOTAL FOR 1928-29	237,441	134,375	371,810	803	2,145,201	200,941	1,200,731	303,958	11,237	115,767	1,800,428	4,708	
	(b) Indian States.												
Mysore	8,500	10,184	24,774	57	250,500	12,717	29,218	20,049	7,500	..	287,812	..	
Hyderabad	6,145	2,740	8,845	70	153,007	..	50,452	2,290	145	2,240	27,820	79	

Showing the working of the Veterinary Departments in India during 1929-30 and 1930-31—contd.

Province	REPORTED MORTALITY FROM CONTAGIOUS DISEASES				DISPENSARIES AND HOSPITALS			DISTRICT WORK					
	Plunderpest	Other diseases	Total	Number of Institutions	Cases treated	Castrations performed	Cases treated	Castrations performed	Outbreaks in which inoculation was undertaken	Deaths unaccounted	Inoculations*	Deaths after inoculations	
(c) British India.													
Madras	59,323	40,858	99,981	122	178,053	8,312	50,541	15,175	1,860	34,808	175,847	507	
Bombay	28,187	0,865	34,852	106	216,788	24,481	28,941	12,360	1,506	19,707	202,328	342	
Bengal	9,345	3,664	18,009	48	94,001	134	136,747	210	462	8,186	90,069	482	
United Provinces	25,919	11,837	37,756	160	315,026	10,600	87,272	5,980	1,743	15,994	193,080	187	
Punjab	6,142	11,486	17,028	287	1,178,942	292,817	280,008	187,005	930	7,054	450,483*	177	
Burma	7,013	2,888	9,809	5	14,862	16	120,387	91	708	4,121	81,179*	575	
Bihar and Orissa	28,541	5,188	33,729	120	70,903	11,540	137,170	67,804	487	4,570	70,941	540	
Central Provinces	12,144	5,832	17,970	100	270,963	9,810	294,439	82,776	1,378	7,874	229,177	142	
Assam	16,442	13,417	29,859	3	4,050	200	87,427	12,233	341	8,900	24,286	509	
North-West Frontier Province	90	1,106	1,198	19	84,887	15,142	50,660	30,530	39	242	8,334	..	
Sind	10,455	2,920	13,375	18	28,938	1,633	3,712	435	133	2,050	12,901	98	
Baluchistan	..	7,479	7,479	10	25,070	165	57,284	117	5	400	289	..	
Rajputana	157	14	171	2	4,401	10	309†	..	5	126	778	..	
TOTAL	203,758	118,152	310,910	1,012	2,485,389	284,908	1,355,877	415,120	9,403	115,057	1,548,982	3,598	
TOTAL FOR 1929-30	271,004	149,574	421,178	891	2,320,085	243,562	1,480,998	353,628	12,167	168,539	2,026,520	5,314	
Mysore	4,239	18,308	22,545	60	108,206	17,264	39,003	43,504	982	8,181	208,079	405	
Hyderabad	18,806	1,854	20,520	70	193,400	..	59,407	10,072	423	12,782	94,158	48	

* Includes vaccinations also.
† Includes castrations also.

* Includes vaccinations also.

† Includes castrations also.

APPENDIX XI.

Showing the working of the Veterinary Colleges and Schools in India during 1929-30 and 1930-31.

		1929-30.									
Veterinary College or School	Course of Instruction.	NUMBER OF STUDENTS				REMAINING UNDER INSTRUCTION AT END OF THE YEAR		STUDENTS ADMITTED DURING THE YEAR CLASSIFIED BY EDUCATIONAL QUALIFICATIONS			
		ADMITTED DURING THE YEAR		Passed final examination during the year	Failed to pass final examination	In ordinary course	Instruction prolonged by reason of failure to pass	Matriculates, school or with higher qualifications	Knowing some English but not matriculates	Knowing no English or very little English	
		Scholarship holders	Others								
Madras Veterinary College	3 years course .	40	16	18	7	50	22	56	..	..
	Refresher course .	7		7*	..	..	..	..	..	..
Bombay Veterinary College	Veterinary Science	8	56	24	5	108	22	53	6	..	
Bengal Veterinary College	3 years course .	30	10	40	20	77	46	42	7	..	
Punjab Veterinary College	4 years course .	61		16	..	189	..	61	..	..
	Post Refresher course.	3		1	..	3	..	..	..	..
Inseln Veterinary School	3 years vernacular course.	..	..	13	..	..	..	..	..	..

* All granted certificates.

Showing the working of the Veterinary Colleges and Schools in India during 1929-30 and 1930-31—concl'd.

		1930-31.										STUDENTS ADMITTED DURING THE YEAR CLASSED BY EDUCATIONAL QUALIFICATIONS		
Veterinary College or School	Course of Instruction	NUMBER OF STUDENTS						REMAINING UNDER INSTRUCTION AT THE END OF THE YEAR		Matriculates, School finds or with higher qualifications	Knowing some English but not matriculates				Knowing no English or very little English
		ADMITTED DURING THE YEAR		Passed final examination during the year	Failed to pass final examination	In ordinary course	Instruction prolonged by reason of failure to pass							
		Scholarship holders	Others											
Madras Veterinary College	{ 3 years course . Refresher course .	20	32	27	5	60	26	52	..	..	..
		8		8*	..	..	..	..	..	..	..
Bombay Veterinary College	Veterinary science	11	30	10	7	115	22	50	..	..	..
Bengal Veterinary College	3 years course .	34	24	34	15	72	31	110	..	22	..			
Punjab Veterinary College	{ 4 years course . Post Refresher course.	22	14	38	13	106	26	36	..	..	..
		5	..	3	..	..	..	..	..	..	..
Isaiah Veterinary School	3 years vernacular course.	..	..	..	..	..	..	..	..	..	..
Bihar and Orissa Veterinary College.	3 years course .	47†	5	10	5	24	15	50	..	2	..			

* All granted certificates.

† Includes students transferred from Bengal Veterinary College.

APPENDIX XII.

Showing the number of cattle issued from Government Farms during 1929-31.

Province	Bulls	Cows	Male buffaloes	She buffaloes	Young stock	Total for 1929-30	Bulls	Cows	Male buffaloes	She buffaloes	Young stock	Total for 1930-31	Total for 1929-31
Madras . . .	44	43	6	4	23	120	51	39	11	3	20	124	156
Bombay . . .	30	32	..	..	27	98	42	30	..	..	47	119	204
Bengal . . .	..	18	..	..	..	18	10	..	..	..	..	10	14
United Provinces .	468	..	100	..	..	503	293	..	330	..	..	611	770
Punjab . . .	335	1	..	..	2	338	205	..	..	..	..	295	486
Bihar and Orissa .	4	34	37	3	44	122	..	44	12	..	97	153	158
Central Provinces .	28	71	..	1	91	191	27	23	1	8	36	95	222
Assam . . .	21	9	..	..	7	37	0	33	..	..	13	65	29
North-West Frontier Province.	..	..	..	..	..	50	2	3	..	..	6	11	5
Sind . . .	..	..	..	..	..	11	12	12	..	..	22	46	..
Imperial Farms.													
Pusa . . .	1	13	..	..	70	90	1	52	..	..	110	103	72
Karnal . . .	..	31	..	1	14	40	..	40	1	..	116	157	102
Bangalore . . .	1	20	..	1	61	89	2	28	..	3	43	76	54
Wellington . . .	1	19	..	..	18	38	2	5	..	..	47	54	12

APPENDIX XIII.

List of Agricultural Publications in India during 1929-31.

No.	Title	Author	Where published
GENERAL AGRICULTURE			
1	<i>The Agricultural Journal of India</i> , Vol. XXIV, Parts IV, V and VI. Price, Re. 1-8 or 2s. per part. Annual subscription Rs. 6 or 9s. 9d.	Edited by the Agricultural Adviser to the Government of India.	Manager of Publications, Civil Lines, Delhi.
2	<i>The Agricultural Journal of India</i> , Vol. XXV, Parts I, II, III, IV, V and VI. Price, Re. 1-8 or 2s. per part. Annual subscription, Rs. 6 or 9s. 9d.	Issued under the authority of the Imperial Council of Agricultural Research.	Ditto.
3	<i>Agriculture and Live-stock in India</i> , Vol. I, Parts I, II and III. Price, Re. 1-8 or 2s. 6d. per part. Annual subscription, Rs. 6 or 9s. 9d.	Ditto	Ditto.
4	<i>The Journal of the Mysore Agricultural and Experimental Union</i> (Quarterly). Annual subscription, Rs. 3.	B. Narashinha Iyengar	Bangalore Press, Bangalore.
5	<i>The Madras Agricultural Journal</i> (Monthly). Annual subscription, Rs. 4; single copy, As. 6.	T. V. Ramakrishna Ayyar	The Scholar Press, Palghat.
6	<i>Poona Agricultural College Magazine</i> (Quarterly). Annual subscription, Rs. 2-8; single copy, As. 10.	V. G. Deshpande and S. M. Rao.	Aryabhushan Press, Poona City.
7	<i>The Nagpur Agricultural College Magazine</i> (Quarterly). Annual subscription, Rs. 3.	P. D. Nair	The Huxley Press, Madras.
8	<i>The Allahabad Farmer</i> (Quarterly). Single copy, As. 8. (Per year Rs. 2).	W. B. Hayes	The Mission Press, Allahabad.
9	<i>Quarterly Journal of the Indian Tea Association</i> . Price As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Press, Calcutta.
10	<i>The Planters' Chronicle</i> (Weekly). Price, As. 8 per copy.	F. E. James	Diocesan Press, Post Box 455, Madras.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
11	<i>Rural India</i> (Monthly). Single copy As. 6. Annual subscription, Rs. 3.	A. Swaminatha Aiyer	Magazine Press, Chingleput.
12	<i>Journal of the Trichinopoly Agricultural Association</i> (Quarterly). Annual subscription, Rs. 1-8 for non-members, free for members.	Issued by the Trichinopoly District, Agricultural Association.	Sri Nilayam Press, Trichinopoly.
13	Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau) for the year 1928-29. Price, Rs. 2-8 or 4s. 6d.	Issued by the Imperial Institute of Agricultural Research, Pusa.	Manager of Publications, Civil Lines, Delhi.
14	Scientific Reports of the Imperial Institute of Agricultural Research, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert and Secretary, Sugar Bureau) for the year 1929-30. Price, Rs. 3-8 or 6s.	Ditto	Ditto.
15	Review of Agricultural Operations in India, 1928-29. Price, Rs. 3-2 or 5s. 6d.	Issued by the Imperial Council of Agricultural Research.	Ditto.
16	Proceedings of the Board of Agriculture in India, held at Pusa on the 9th December 1929 and following days (with Appendices). Price, Rs. 3-10 or 6s 3d.	Issued by the Government of India.	Ditto.
17	Annual Report of the Indian Central Cotton Committee, Bombay, 1929. Price Rs. 2.	J. H. Ritchie	G. Claridge & Co., Bombay.
18	Annual Report of the Indian Central Cotton Committee, Bombay, 1930. Price, Rs. 2.	Ditto	Ditto.
19	Report on the Operations of the Department of Agriculture, Madras Presidency for the year 1928-29.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
20	Report on the Operations of the Department of Agriculture, Madras Presidency for the year 1929-30.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
21	Villagers' Calendar, 1929 and 1930 (English).	Ditto	Ditto.
22	Villagers' Calendar for 1929-30 (Tamil, Telugu, Kanarese and Malayalam).	Ditto	Ditto.
23	Villagers' Calendar for 1930-31 (Kanarese, Telugu, Tamil and Malayalam).	Ditto	Ditto.
24	Care and management of cattle manure in South India. (Madras Department of Agriculture Leaflet No. 24. English, Tamil, Telugu, Malayalam and Kanarese).	V. Muthuswami Ayyar	Ditto.
25	Green manuring. (Madras Department of Agriculture Leaflet No. 25. English, Tamil, Telugu, Malayalam and Kanarese).	B. Ramiah	Ditto.
26	Revised Note on tapioca. (Madras Department of Agriculture Leaflet No. 26. English, Tamil, Telugu, Malayalam and Kanarese).	K. Unnikrishna Menon	Ditto.
27	Telugu songs on improved method of paddy cultivation. (Madras Department of Agriculture Leaflet No. 27. Telugu)	D. Balakrishnamurthi	Ditto.
28	Weeds—weeds—weeds. (Madras Department of Agriculture Leaflet No. 28. English, Tamil, Telugu, Kanarese and Malayalam).	D. T. Chadwick	Ditto.
29	The Sindhewabo furnace for Jaggery manufacture. (Madras Department of Agriculture Leaflet No. 29. English, Tamil, Telugu, Kanarese and Malayalam).	C. Narayana Ayyar	Ditto.
30	Pure cotton. (Madras Department of Agriculture Leaflet No. 33. English and Tamil).	B. Ramiah	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
31	The Improvement of Sugarcane seed (English and Telugu). Madras Department of Agriculture Leaflet No. 58.	A. C. Edmunds . . .	Government Press, Madras.
32	The Production of Fodder and Green Manure seeds (English and Telugu). Madras Department of Agriculture Leaflet No. 59.	Ditto . . .	Ditto.
33	Bread Hints for every-day use (English). Madras Department of Agriculture Leaflet No. 64.	G. R. Hilson . . .	Ditto.
34	Potatoes (English, Telugu, Tamil, Malayalam and Kanarese). Madras Department of Agriculture Leaflet No. 65.	F. H. Butcher . . .	Ditto.
35	Note on Turmeric (English, Telugu, Tamil, Malayalam and Kanarese). Madras Department of Agriculture Leaflet No. 67.	Issued by the Department of Agriculture, Madras.	Ditto.
36	School Garden (English, Tamil, Telugu, Kanarese and Malayalam). Madras Department of Agriculture Leaflet No. 68.	Ditto . . .	Ditto.
37	Water rate or Fasaliyasti for certain crops—concession made by Government to ryots in aid of cultivation (English, Telugu, Tamil, Kanarese and Malayalam). Madras Department of Agriculture Leaflet No. 69.	Ditto . . .	Ditto.
38	How to send specimens (English, Tamil, Telugu and Malayalam). Madras Department of Agriculture Leaflet No. 71 and 71(a).	S. R. Srinivasa Iyengar . .	Ditto.
39	Planting of Trees. Standing Order of the Board of Revenue, Land Revenue and Settlement (English, Malayalam, Telugu and Tamil). Madras Department of Agriculture Leaflet No. 73.	Issued by the Department of Agriculture, Madras.	Ditto.

314 AGRICULTURAL OPERATIONS IN INDIA, 1929-30 AND 1930-31

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE— <i>contd.</i>			
40	Loan to ryots (English, Telugu, Tamil, Kanarese and Malayalam). Madras Department of Agriculture Leaflet No. 74.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
41	Results of Demonstrations of Agricultural Improvements in the Madras Circle carried out in 1924-27. Madras Department of Agriculture Bulletin No. 97.	D. Ananda Rao . . .	Ditto.
42	Popper cultivation in the West Coast (English, Malayalam and Kanarese). Madras Department of Agriculture Bulletin No. 98.	M. Govinda Kidavu and P. A. Venkateswaram.	Ditto.
43	Results of Experiments at Samalkota in Intermediate Season Cropping. Madras Department of Agriculture Bulletin No. 99.	A. C. Edmunds and G. Jogiraju.	Ditto.
44	Results of Experiments conducted at the Agricultural Research Station, Palur (English). Madras Department of Agriculture Pamphlet No. 2.	D. Ananda Rao and A. Ramaswami Ayyar.	Ditto.
45	Notes on the result of chemical, entomological and mycological experiments conducted at the Research Station, Vallalur, during 1925-30. Madras Department of Agriculture Pamphlet No. 3 (English, Tamil, Telugu, Malayalam and Kanarese).	B. Viswanath, Y. Ramachandra Rao and S. Sundararama Ayyar.	Ditto.
46	Digest of the Operations of the Department of Agriculture, Madras, for quarter ending 31st March 1930 (English, Tamil, Telugu and Malayalam). Madras Department of Agriculture Digest No. 87.	D. Ananda Rao . . .	Ditto.
47	Digest of the Operations of the Department of Agriculture, Madras, for quarter ending 30th June 1930 (English, Tamil, Telugu and Malayalam). Madras Department of Agriculture Digest No. 88.	Ditto . . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
48	Digest of the Operations of the Department of Agriculture, Madras, for quarter ending 30th September 1930 (English, Tamil, Telugu, Malayalam and Kanarese). Madras Department of Agriculture Digest No. 89.	D. Anando Rao . .	Government Press, Madras.
49	Digest of the Operations of the Department of Agriculture, Madras, for the quarter ending 30th December 1930. Madras Department of Agriculture Digest No. 90 (English, Tamil, Telugu, Malayalam and Kanarese).	Ditto . .	Ditto.
50	Digest of the operations of the Department of Agriculture, Madras, for the quarter ending 31st March 1931. Madras Department of Agriculture Digest No. 91. (English, Tamil, Telugu, Malayalam and Kanarese).	Ditto . .	Ditto.
51	Broad Hints for every-day use, No. 1 (English, Telugu, Tamil, Malayalam and Kanarese).	G. R. Hilson . .	Ditto.
52	Plough early. (English, Tamil, Telugu, Malayalam and Kanarese). Madras Department of Agriculture Broad Hints for every-day use, No. III	D. Ananda Rao . .	Ditto.
53	Plough efficiently. (English, Tamil, Telugu and Kanarese). Madras Department of Agriculture Broad Hints for every-day use, No. IV.	Ditto . .	Ditto.
54	Sow good seed. (English, Tamil, Telugu and Kanarese). Madras Department of Agriculture Broad Hints for every-day use, No. V.	G. R. Hilson . .	Ditto.
55	Beware of weeds. (English, Telugu, Malayalam and Kanarese). Madras Department of Agriculture Broad Hints for every-day use, No. VI.	Ditto . .	Ditto.

316 AGRICULTURAL OPERATIONS IN INDIA, 1929-30 AND 1930-31

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
56	Note on Pure Paddy Seed, VIII Circle. (English and Tamil). Madras Department of Agriculture Note No. 1.	R. C. Broadfoot . . .	Government Press, Madras.
57	Note on Pure Paddy Seed, I Circle. (English and Telugu). Madras Department of Agriculture Note No. 2.	A. C. Edmunds . . .	Ditto.
58	Note on Pure Paddy Seed, VI Circle. (English and Tamil). Madras Department of Agriculture Note No. 3.	B. Ramiah . . .	Ditto.
59	Some suggestions to the ryots of the IV Circle to obtain and keep paddy seed pure. (English, Tamil and Telugu). Madras Department of Agriculture Notes No. 4.	M. Govinda Kidavu . . .	Ditto.
60	Annual Report of the Department of Agriculture in the Bombay Presidency for the year 1928-29.	Issued by the Department of Agriculture, Bombay.	Government Press, Bombay.
61	Annual Report of the Department of Agriculture in the Bombay Presidency for the year 1929-30.	Ditto. . .	Ditto.
62	Useful hints for the cultivation of groundnut (Guzarati). Bombay Department of Agriculture Leaflet No. 3 of 1930.	Ditto . . .	Ditto.
63	Important hints to growers of Bauilla Cotton (Marathi). Bombay Department of Agriculture Leaflet No. 4 of 1930.	Ditto . . .	Ditto.
64	Reclamation of salt lands in the Gokak canal tract. Bombay Department of Agriculture Leaflet No. 5 of 1930.	Ditto . . .	Ditto.
65	Economic manures for garden crops in the North Konkan. Bombay Department of Agriculture Leaflet No. 8 of 1930.	Ditto . . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
66	Risks associated with the practice of suspense sales of seed—cotton and advice upon how to pack seed—cotton in carts (Marathi). Bombay Department of Agriculture Leaflet No. 10 of 1930.	Issued by the Department of Agriculture, Bombay.	Government Press Bombay.
67	Rabi cultivation of chillies in the Konkan. Bombay Department of Agriculture Leaflet No. 11 of 1930.	Ditto	Ditto.
68	Study in intensive farming near Poona under canal irrigation. Bombay Department of Agriculture Bulletin No. 164 of 1930.	B. S. Patel and H. M. Desai	Ditto.
69	Frost of January 1929 and its damage to crops of the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 165 of 1930. Price, As. 6.	K. V. Joshi	Ditto.
70	Annual Report of the Department of Agriculture, Bengal, 1928-29.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
71	Annual Report of the Department of Agriculture, Bengal, 1929-30. Price, Rs. 4-5 or 7s.	Ditto	Ditto.
72	Artificial fertilizers. Bengal Department of Agriculture Leaflet No. 4 of 1929.	Ditto	Ditto.
73	Cultivation of English Vegetables. Bengal Department of Agriculture Leaflet No. 5 of 1929.	Ditto	Ditto.
74	Tobacco in Bengal. Bengal Department of Agriculture Leaflet No. 6 of 1929.	Ditto	Ditto.
75	Notes on crops which can be substituted for jute. (English and Bengali). Bengal Department of Agriculture Leaflet No. 7 of 1929.	Ditto	Ditto.
76	Notes on why fodder crops should be substituted for jute and paddy (English and Bengali). Bengal Department of Agriculture Leaflet No. 1 of 1931.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author ,	Where published
GENERAL AGRICULTURE—contd.			
77	Dudsar paddy (English and Bengali). Bengal Department of Agriculture Leaflet No. 3 of 1931.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
78	Notes on improved method of Agriculture for Bengal with improved implements specially designed and locally constructed to suit the soils, the cattle and the pocket of the Bengali cultivator (English and Bengali). Leaflet No. 4 of 1931 of the Department of Agriculture, Bengal.	Ditto	Ditto.
79	Improved ploughs for the use of the Bengal cultivators.	Ditto	Ditto.
80	Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1929.	Issued by the Department of Agriculture, United Provinces.	Government Allahabad. Press,
81	Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1930.	Ditto	Ditto.
82	Report on the Agricultural Stations of the Central Circle, Cawnpore, United Provinces, for the year ending June 30, 1929.	Ditto	Ditto.
83	Report on the Agricultural Stations of the Central Circle, Cawnpore, United Provinces, for the year ending June 30, 1930.	Ditto	Ditto.
84	Report on the Agricultural Stations of the Western Circle, Aligarh, United Provinces, for the year ending June 30, 1929.	Ditto	Ditto.
85	Report on the Agricultural Stations of the Western Circle, Aligarh, United Provinces, for the year ending June 30, 1930.	Ditto	Ditto.
86	Combined Report on the Experimental Stations in Eastern Circle, Partabgarh, United Provinces, for the year ending May 31, 1929.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
87	Combined Report on the Experimental Stations in Eastern Circle, Partabgarh, United Provinces, for the year ending May 31, 1930.	Issued by the Department of Agriculture, United Provinces.	Government Press, Allahabad.
88	Report on the Agricultural Stations of the North-Western Circle, Gorakhpur, United Provinces, for the year ending June 30, 1929.	Ditto	Ditto.
89	Report on the Agricultural Stations of the North-Eastern Circle, Gorakhpur, United Provinces, for the year ending June 30, 1930.	Ditto	Ditto.
90	Report on the Agricultural Stations in the Rohilkhand Circle, Shahjahanpur, United Provinces, for the year ending June 30, 1929.	Ditto	Ditto.
91	Report on the Agricultural Stations in the Rohilkhand Circle, Shahjahanpur, United Provinces, for the year ending June 30, 1930.	Ditto	Ditto.
92	Report on the Agricultural Stations of the Bundelkhand Circle, United Provinces, for the year ending June 30, 1929.	Ditto	Ditto.
93	Report on the Agricultural Stations of the Bundelkhand Circle, United Provinces, for the year ending June 30, 1930.	Ditto	Ditto.
94	Report on the Agricultural Stations in the Hill Circle, United Provinces, for the year ending June 30, 1929.	Ditto	Ditto.
95	Report on the Agricultural Stations in the Hill Circle, United Provinces, for the year ending June 30, 1930.	Ditto	Ditto.
96	Report on the Working and Administration of the United Provinces, Government Gardens for the year 1928-29.	Ditto	Ditto.

320 AGRICULTURAL OPERATIONS IN INDIA, 1929-30 AND 1930-31

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
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GENERAL AGRICULTURE—*contd.*

97	Report on the Working and Administration of the United Provinces Gardens for the year 1929-30.	Issued by the Department of Agriculture, United Provinces.	Government Press, Allahabad.
98	Introduction of Long Staple Cotton in the United Provinces, its past, present and future.	B. Ram Prasad . . .	Ditto.
99	Bulletin No. 50 of the Department of Agriculture, United Provinces.	Jai Krishna Mathur . .	Ditto.
100	Organisation of Wheat Trade in N.-W. Region. Bulletin No. 51 of the Department of Agriculture, United Provinces.	Tiryngi Prasad . . .	Ditto.
101	Economic survey of a village in Cawnpore. Bulletin No. 52 of the Department of Agriculture, United Provinces.	Ram Misra . . .	Ditto.
102	Experiments in Electric Farming. Bulletin No. 53 of the Department of Agriculture, United Provinces.	S. S. Nehru . . .	Ditto.
103	Dynamometer tests and efficiency of some Improved Ploughs. Bulletin No. 54 of the Department of Agriculture, United Provinces.	G. Maya Das . . .	Ditto.
104	A brochure of School Gardens. Bulletin No. 55 of the Department of Agriculture, United Provinces. (Revised edition).	Issued by the Department of Agriculture, United Provinces.	Ditto.
105	The Farm Tractor in India. Bulletin No. 56 of the Department of Agriculture, United Provinces.	G. Maya Das . . .	Ditto.
106	Report on Cotton Purchase Operations, 1929-30 and 1930-31. Bulletin No. 57 of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Provinces.	Ditto.
107	C. 402, a new variety of Long Staple cotton in the United Provinces. Bulletin No. 58 of the Department of Agriculture, United Provinces.	Ram Prasad . . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
108	Studies in Agricultural Improvement.	C. Maya Das	Government Press, Allahabad.
109	Report on the Operations of the Department of Agriculture, Punjab, for the year ending June 30, 1929. Part I. Price Rs. 1-6, Part II, Vol. I. Price, Rs. 6 and Vol. II. Price, Rs. 20.	Issued by the Department of Agriculture, Punjab.	Government Printing, Lahore.
110	Annual Report of the Department of Agriculture, Punjab, for the year ending June 30, 1930. Part I. Price, Rs. 1-6 or 2s. 2d. per copy.	Ditto	Ditto.
111	<i>Seasonal Notes of the Punjab Department of Agriculture</i> (Half-yearly). Price, per issue, As. 4.	Ditto	Ditto.
112	A note of 289-F. American Cotton for farmers. Punjab Department of Agriculture Leaflet No. 74.	Ditto	Ditto.
113	Some hints for making a lawn. Punjab Department of Agriculture Leaflet No. 75.	Ditto	Ditto.
114	Sugarcane crushing. Punjab Department of Agriculture Leaflet No. 76.	Ditto	Ditto.
115	Damping of cotton. Punjab Department of Agriculture Leaflet No. 80.	Ditto	Ditto.
116	Information regarding Boring of Wells by the Agricultural Department, Punjab. Punjab Department of Agriculture Leaflet No. 84.	Ditto	Ditto.
117	Hints on cotton cultivation. Punjab Department of Agriculture Leaflet No. 86.	Ditto	Ditto.
118	How to succeed with berseem. Punjab Department of Agriculture Leaflet No. 90.	Ditto	Ditto.
119	Reclamation of Kalar Soils. Punjab Department of Agriculture Leaflet No. 91.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
120	Methods of Legume inoculation. Punjab Department of Agriculture Leaflet No. 92.	Issued by the Department of Agriculture, Punjab.	Government Printing, Lahore.
121	Rule for the Control of well borers.	Ditto	Ditto.
122	Guide to the Punjab Agricultural College and Research Institute, Lyallpur.	Ditto	Ditto.
123	Enquiries regarding Indian oil-seed crops. Price, As. 9.	K. S. Ch. Ali Mohammad	Ditto.
124	Prospectus of the Punjab Agricultural College, Lyallpur. Price, As. 4.	Issued by the Department of Agriculture, Punjab.	Ditto.
125	Potato crop and its improvement in the Punjab. Price, As. 6.	D. Milne and K. S. Ch. Ali Mohammad.	Ditto.
126	Enquiries regarding Indian oil-seed crops (Urdu). Price, Annas 5 per copy.	K. S. Ch. Ali Mohammad	Ditto.
127	Annual Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June, 1929. Price, Rs. 1-8 or 2s. 3d.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
128	Annual Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June, 1930.	Ditto	Ditto.
129	Annual Report of the Principal, Agricultural College and Research Institute, Burma, Mandalay, for the year ending 30th June, 1929.	Ditto	Ditto.
130	Annual Report of the Principal, Agricultural College, and Research Institute, Burma, Mandalay, for the year ending 30th June, 1930.	Ditto	Ditto.
131	Report on the Hmawbi Agricultural Station, for the year ending 30th June, 1929.	Ditto	Ditto.
132	Report on the Hmawbi Agricultural Station, for the year ending 30th June, 1930.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
133	Report on the Mudon Agricultural Station, for the year ending 30th June, 1929.	Issued by the Department of Agriculture, Burma.	Government, Printing, Burma, Rangoon.
134	Report on the Mudon Agricultural Station, for the year ending 30th June, 1930. Price, Rs. 1 or 1s. 6d.	Ditto .	Ditto.
135	Report on the Mahlaing Experimental Station, for the year ending 30th June, 1929.	Ditto .	Ditto.
136	Report on the Mahlaing Experimental Station, for the year ending 30th June, 1930.	Ditto .	Ditto.
137	Report on the Pwinbyu Seed Farm, for the year ending 30th June, 1929.	Ditto .	Ditto.
138	Report on the Pwinbyu Seed Farm, for the year ending 30th June, 1930.	Ditto .	Ditto.
139	Report on the Pyinmana Agricultural Station, for the year ending 30th June, 1929.	Ditto .	Ditto.
140	Report on the Pyinmana Agricultural Station for the year ending 30th June, 1930.	Ditto .	Ditto.
141	Report on the Yaungthwe Agricultural Station and Agricultural work in the Southern Shan States, for the year ending 30th June, 1929.	Ditto .	Ditto.
142	Report on the Yaungthwe Agricultural Station and Agricultural Work in the Southern Shan States, for the year ending 30th June, 1930.	Ditto .	Ditto.
143	The combined report on the Akyab Agricultural Station and Kyaukpyau coconut farm for the year ending 30th June, 1929. Price, As. 12 or 1s. 1d.	Ditto .	Ditto.
144	The combined report on the Akyab Agricultural Station and Kyaukpyau coconut farm for the year ending 30th June, 1930. Price, As. 12 or 1s. 1d.	Ditto .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
145	Report on the Myaungmya Agricultural Station, for the year ending 30th June, 1929.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
146	Report on the Myaungmya Agricultural Station, for the year ending 30th June, 1930.	Ditto	Ditto.
147	Report on the Padu Agricultural Station, for the year ending 30th June, 1929.	Ditto	Ditto.
148	Report on the Padu Agricultural Station for the year ending 30th June, 1930.	Ditto	Ditto.
149	Report on the Allanmyo Agricultural Station, for the year ending 30th June, 1929.	Ditto	Ditto.
150	Report on the Allanmyo Agricultural Station, for the year ending 30th June, 1930.	Ditto	Ditto.
151	Report on the Mandalay Agricultural College Farm, for the year ending 30th June, 1929.	Ditto	Ditto.
152	Report on the Mandalay Agricultural College Farm, for the year ending 30th June, 1930.	Ditto	Ditto.
153	Report on the Tatkon Agricultural Station, for the year ending 30th June, 1929.	Ditto	Ditto.
154	Report on the Tatkon Agricultural Station, for the year ending 30th June, 1930.	Ditto	Ditto.
155	Report on the Sa-ning Sub-station for the year ending 30th June, 1929.	Ditto	Ditto.
156	Report on the Sa-ning Sub-station, for the year ending 30th June, 1930. Price, As. 2 or 2d.	Ditto	Ditto.
157	Report of the Agricultural Engineer, Burma, for the year ending 30th June, 1929.	Ditto	Ditto.
158	Report of the Agricultural Engineer, Burma, for the year ending 30th June, 1930.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
159	Agricultural Calendar, Burma .	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
160	Instructions for testing Agricultural seeds. Burma Cultivators' Leaflet No. 62.	Ditto .	Ditto.
161	Manuring of Paddy in Upper Burma. Burma Department of Agriculture Bulletin No. 27 of 1930. Price, As. 12 or 1s. 1d.	Ditto	Ditto.
162	The Bean crop in Burma, Agricultural Survey No. 8.	Ditto .	Ditto.
163	Survey of conditions of cotton marketing in Berar. Agricultural Survey No. 9.	Ditto .	Ditto.
164	Annual Report of the Department of Agriculture, Bihar and Orissa, for the year 1928-29.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing, Bihar and Orissa, Gularbagh.
165	Annual Report of the Department of Agriculture, Bihar and Orissa, for 1929-30.	Ditto .	Ditto.
166	Annual Report on Experimental Farms, Bihar and Orissa, for 1928-29.	Ditto .	Ditto.
167	Annual Report on Experimental Farms, Bihar and Orissa, for 1929-30.	Ditto .	Ditto.
168	Annual Report on Experimental Stations in Bihar and Orissa, 1928-29.	Ditto .	Ditto.
169	Annual Report on Experimental Stations in Bihar and Orissa, 1929-30.	Ditto .	Ditto.
170	Bunds in Chota Nagpur Range (English, Bengali and Hindi). Bihar and Orissa Department of Agriculture Bulletin No. 1 of 1930.	Ditto .	Ditto.
171	Sugarcane in Chota Nagpur (English, Bengali, Oriya and Hindi). Bihar and Orissa Department of Agriculture Bulletin No. 2 of 1930.	Ditto .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
172	Summary of Improvements in Agriculture recommended by the Department of Agriculture, Bihar and Orissa Department of Agriculture Bulletin No. 3 of 1930.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bilas and Orissa, Gulzarbagh.
173	Leaflet on Sugarcane in South-east Bihar Range. Leaflet No. 1 of 1930.	Ditto.	Ditto
174	Sugarcane for Orissa Range. (English and Oriya). Bihar and Orissa Department of Agriculture Leaflet.	Ditto	Ditto.
175	Sugarcane Crushing Mill—its advantages and care. Bihar and Orissa Department of Agriculture Leaflet No. 1 of 1931.	Ditto	Ditto.
176	Water lifts in Bihar and Orissa. Bihar and Orissa Department of Agriculture Leaflet No. 2 of 1931.	Ditto	Ditto.
177	Report on the working of the Department of Agriculture of the Central Provinces, for the year ending 31st March, 1929. Price, Re. 1-7.	Issued by the Department of Agriculture, Central Province.	Government Press, Nagpur.
178	Report on the working of the Department of Agriculture of the Central Provinces, for the year ending 31st March, 1930.	Ditto	Ditto.
179	Report on the (1) Agricultural College, Nagpur, (2) Chemical, Botanical, Mycological and Entomological Research, (3) Agricultural Engineer's Section, (4) Maharajbagh Manerie together with the external work of the Veterinary Inspector attached to the Agricultural College, Nagpur, for the year ending 31st March, 1929. Price, Re. 1.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
180	Report on the (1) Agricultural College, Nagpur, (2) Chemical, Botanical Mycological and Entomological Research, (3) Agricultural Engineer's Section, (4) Maharajbagh Menagerie together with the external work of the Veterinary Inspector attached to the Agricultural College, Nagpur, Central Provinces, for the year ending 31st March, 1930. Price, Re. 1.	Issued by the Department of Agriculture, Central Provinces.	Government Press Nagpur.
181	Annual Reports of Experimental Farms of Akola, and the Experimental Farm attached to the Agricultural College, Nagpur, Central Provinces, for the year ending 31st March, 1930. Price, Re. 1.	Ditto	Ditto.
182	Report on Demonstration work carried out in the Western Circle together with reports on the Seed and Demonstration and Cattle Breeding Farms of that circle for the year ending 31st March, 1929. (Vols. I and II). Price, Re. 1 each.	Ditto	Ditto.
183	Report on Demonstration work carried out in the Western Circle, Central Provinces, together with the Reports on the Seed and Demonstration and Cattle Breeding Farms of that Circle for the year ending 31st March, 1930. Vol. I. Price, Re. 1.	Ditto	Ditto.
184	Report on Demonstration work carried out in the Eastern Circle, Central Provinces, together with reports on the Seed and Demonstration Farms at Chandkhuri, Bilaspur and Drug with that of Cattle Breeding Stations attached thereto for the year ending 31st March, 1929. Price, Re. 1.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
185	Report on Demonstration work carried out in the Eastern Circle, Central Provinces, together with reports on the Seed and Demonstration Farms at Chandkhuri, Bilaspur and Drug with that of Cattle Breeding Stations attached thereto for the year ending 31st March, 1930. Price, Rs. 2-12.	Issued by the Department of Agriculture, Central Provinces.	Government Nagpur. Press,
186	Report on Demonstration work carried out in Southern Circle together with reports on the Seed and Demonstration Farms, Waraseoni and Sindewahi and the Cattle Breeding Farm, Sindewahi, Central Provinces, for the year ending 31st March, 1929. Price, Re. 1.	Ditto	Ditto.
187	Report on Demonstration work carried out in the Southern Circle, Central Provinces, together with the Reports on the Seed and Demonstration Farms, Waraseoni and Sindewahi and the Cattle Breeding Farm, Sindewahi, for the year ending 31st March, 1930. Price, Re. 1.	Ditto	Ditto.
188	Annual Reports of Experimental Farms of the Southern and Eastern Circles, Tharua and Raipur, Central Provinces, for the year ending 31st March, 1929. Price, Re. 1.	Ditto	Ditto.
189	Annual Reports of Experimental Farms of the Southern and Eastern Circles, Tharua and Raipur, Central Provinces, for the year ending 31st March, 1930. Price, Re. 1.	Ditto	Ditto.
190	Report on Demonstration work carried out in the Northern Circle, Central Provinces, together with the Reports on the Seed and Demonstration Farms for the year ending 31st March, 1930.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
GENERAL AGRICULTURE—contd.			
191	Reports on Demonstration work carried out in the Plateau sub-circle, Central Provinces, together with the reports on the Seed and Demonstration Farms of that Circle for the year ending 31st March 1930. Price, Re. 1.	Issued by the Department of Agriculture, Central Provinces.	Government Press, Nagpur.
192	Annual Reports of Experimental Farms of the Northern and Plateau Circles, Powarkhera, Adhartal and Chhindwara, Central Provinces, with that of Cattle Breeding Stations attached thereto for the year ending 31st March, 1930. Price, Re. 1.	Ditto	Ditto.
193	A Marathi Leaflet on some important points of Groundnut cultivation.	Ditto	Ditto.
194	A Marathi version of the Royal Commission's Report (Abridged). Adapted from the Hindi version published by the United Provinces Government.	Ditto	Ditto.
195	The Cultivation of Groundnut (Marathi). Bulletin No. 22 of the Department of Agriculture, Central Provinces. Price, As. 2.	Ditto	Ditto.
196	A Leaflet of instructions about Rouging alien plants from verum (Marathi).	Ditto	Ditto.
197	Annual Report on the working of the Department of Agriculture, Assam, for 1928-29. Price As. 14 or 1s. 4d.	Issued by the Department of Agriculture, Assam.	Government Press, Assam, Shillong.
198	Annual Report on the working of the Department of Agriculture, Assam, for 1929-30.	Ditto	Ditto.
199	Sweet potato (in Assamese, Bengali and Khasi). Assam Department of Agriculture, Leaflet No. 2 of 1929.	Ditto	Ditto.
200	Water-hyacinth. (Assamese.) Assam Department of Agriculture Leaflet No. 1 of 1930.	Ditto	Ditto.

330 AGRICULTURAL OPERATIONS IN INDIA, 1929-30 AND 1930-31

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
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GENERAL AGRICULTURE—*concl'd.*

201	Yellowing of Rice seedlings. (Assamese and Bengali). Assam Department of Agriculture Leaflet No. 2 of 1930.	Issued by the Department of Agriculture, Assam.	Government Press, Assam, Shillong.
202	How to improve yield in Paddy. Leaflet No. 2 of 1931 of the Department of Agriculture, Assam. (English, Assamese and Bengali.)	Ditto . .	Ditto.
203	Report of the Mysore Agricultural Department for the year ending 30th June 1930, Parts I and II.	Issued by the Director of Agriculture, Mysore.	Government Press, Bangalore.
203(a)	Report of the Mysore Agricultural Department for the year ending 30th June 1931, Parts I and II.	Ditto . .	Ditto.

AGRICULTURAL STATISTICS.

204	Agricultural Statistics of India, 1927-28. Vols. I and II. Price, Re. 1-4 per volume.	Issued by the Department of Commercial Intelligence and Statistics, India.	Government of India Central Publication Branch, Calcutta.
205	Agricultural Statistics of India, 1928-29. Vols. I and II. Price, Re. 1-6 and Re. 1-8 resp.	Ditto . .	Ditto.
206	Estimates of Area and Yield of Principal crops in India, 1928-29. Price, As. 14 or 1s. 6d.	Ditto . .	Ditto.
207	Estimates of Area and Yield of Principal crops in India, 1929-30. Price, As. 14 or 1s. 6d.	Ditto . .	Ditto.
208	Season and Crop Report of the Madras Presidency for Agricultural year 1928-29. Price, Re. 1-4.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
209	Season and Crop Report of the Madras Presidency for Agricultural year 1929-30. Price, Re. 1-4.	Ditto . .	Ditto.
210	Season and Crop Report of the Bombay Presidency for the year 1928-29. Price, As. 5.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
AGRICULTURAL STATISTICS—contd.			
211	Season and Crop Report of the Bombay Presidency for the year 1929-30. Price, As. 5.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
212	Season and Crop Report of Bengal for 1928-29.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
213	Season and Crop Report of Bengal for 1929-30.	Ditto . .	Ditto.
214	Monthly and Annual Rainfall Table in the Province of Bengal for 1929.	Ditto . .	Ditto.
215	Monthly and Annual Rainfall Table in the Province of Bengal for 1930.	Ditto . .	Ditto.
216	Season and Crop Report of the United Provinces of Agra and Oudh for the year 1928-29.	Issued by the Department of Land Records, U. P.	Government Press, Allahabad.
217	Season and Crop Report of the United Provinces of Agra and Oudh for the year 1929-30.	Ditto . .	Ditto.
218	Table of Agricultural Statistics of the Punjab for 1928-29.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
219	Season and Crop Report of the Punjab for 1928-29.	Ditto . .	Ditto.
220	Season and Crop Report of the Punjab for 1929-30.	Ditto . .	Ditto.
221	Agricultural Statistics, Bihar and Orissa, 1928-29.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing, Bihar and Orissa, Gulzarbagh.
222	Agricultural Statistics, Bihar and Orissa, 1929-30.	Ditto . .	Ditto.
223	Season and Crop Report of Bihar and Orissa for 1928-29.	Ditto . .	Ditto.
224	Season and Crop Report of the Central Provinces and Berar for the year 1928-29.	Issued by the Department of Land Records, Central Provinces.	Government Press, Nagpur.
224(a)	Report on the Season and Crops of N.-W. F. P. for 1928-29.	Issued by the Revenue Commissioner, N.-W. F. P.	Government Printing and Stationery, N.-W. F. P.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
FRUIT CULTURE.			
225	The Production of Oranges in Spain. Pusa Bulletin No. 198. Price, As. 6 or 8d.	W. Robertson Brown . .	Government of India Central Publication Branch, Calcutta.
226	Grape Culture in Western India. Bombay Department of Agriculture Bulletin No. 156 of 1928. Price, As. 7.	S. R. Gandhi . . .	Ditto.
227	Papaya cultivation in the Bombay Presidency (excluding Sind). Bombay Department of Agriculture Bulletin No. 162 of 1930. Price, As. 3.	G. S. Cheema and P. G. Dani.	Government Central Press, Bombay.
228	Grading of mangoes. Bombay Department of Agriculture Leaflet No. 1 of 1931.	Issued by the Department of Agriculture, Bombay.	Ditto.
229	A List of Fruit Nurseries in the Punjab recommended for the purchase of Plants. Punjab Department of Agriculture Leaflet No. 73.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
230	Tomato Ketchup. Punjab Department of Agriculture Leaflet No. 77.	Ditto . . .	Ditto.
231	Candying of fruits. Punjab Department of Agriculture Leaflet No. 78.	Ditto . . .	Ditto.
232	How to place oranges in the market. Punjab Department of Agriculture Leaflet No. 79.	Ditto . . .	Ditto.
233	On Protection of Fruit Trees from Frost. Punjab Department of Agriculture Leaflet No. 81.	Ditto . . .	Ditto.
234	Banana Culture (in Assamese and Bengali). Assam Department of Agriculture Leaflet No. 1 of 1929.	Issued by the Department of Agriculture, Assam.	Government Press, Assam, Shillong.
235	Papaya Culture (in Assamese and Bengali). Assam Department of Agriculture Bulletin No. 1 of 1929.	Ditto . . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
SERICULTURE.			
236	The rearing of Eri Silk Worms. Bengal Department of Agriculture Leaflet No. 2 of 1930.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
237	Silk Industry in Bengal. Department of Agriculture Leaflet No. 6 of 1930.	Ditto . . .	Ditto.
AGRICULTURAL SCIENCE.			
237(a)	The Indian Journal of Agricultural Science, Vol. I, Parts I, II and III. Annual Subscription Rs. 10, 16s. 6d.	Issued under the authority of the Imperial Council of Agricultural Research.	Government of India Central Publication Branch, Calcutta.
AGRICULTURAL CHEMISTRY.			
238	The Application of the Antimony Electrode to the Determination of the pH value and the Lime Requirement of Soils. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 4. Price, As. 5 or 6d.	W. H. Harrison and P. N. Vridhaachalam.	Government of India Central Publication Branch, Calcutta.
239	Some Digestibility Trials on Indian Feeding Stuffs, IV: Some Punjab Hays. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 5. Price, As. 7 or 9d.	P. E. Lander and Lal Chand Dharmani.	Ditto.
240	Some Digestibility Trials on Indian Feeding Stuffs, V: Feeding trials on American and Indian cotton seeds. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 6. Price, As. 7 or 9d.	Ditto . . .	Ditto.
241	Some Digestibility Trials on Indian Feeding Stuffs, VI: Green Fodders and their Silage. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 7, Price, As. 10 or 1s.	Ditto . . .	Ditto.
242	A New Method of Dispersing Soils for Mechanical Analysis. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 8. Price, As. 5 or 6d.	Amar Nath Puri . . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
♂ AGRICULTURAL CHEMISTRY—contd.			
243	A Study of the Capillary Rise of Water under Field conditions. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 9. Price, As. 5 or 6 d.	Ashutosh Sen . . .	Government of India Central Publication Branch, Calcutta.
244	Silage Investigations at Bangalore. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 10. Price, As. 10 or 1s.	T. S. Krishnan . . .	Ditto.
245	Studies in Soil Colloids, Part I — Base exchange and soil acidity ; Part II — Factors influencing the dispersion of soil colloids in water. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, Nos. 1 and 2. Price, Re. 1 or 1s. 9d.	Amar Nath Puri . . .	Ditto.
246	Feeding Experiments at Hosur, 1926, 1927 and 1928. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 3. Price, As. 7 or 9d.	F. J. Warth . . .	Ditto.
247	The Nutritive value of some Typical Indian Hays. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 4. Price, As. 5 or 6d.	Ditto . . .	Ditto.
248	The Nutritive value of Gram Husk. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 5. Price, As. 6 or 8d.	F. J. Warth, and Lal Chand Sikka.	Ditto.
249	Studies in Soil Colloids, Part III—Flocculation of soil colloids. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 6. Price, As. 7 or 9d.	Amar Nath Puri . . .	Ditto.
250	Studies in Soil Colloids, Part IV—Methods of estimating soil colloids. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 7. Price, As. 5 or 6d.	Ditto . . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
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AGRICULTURAL CHEMISTRY—*concl'd.*

251	Studies in Soil Colloids, Part V—Methods of determining saturation, capacity and degree of saturation of soils. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 8. Price, As. 3 or 4d.	Amar Nath Puri . . .	Government of India Central Publication Branch, Calcutta.
252	A New Method of Estimating Total Carbonates in Soils. Pusa Bulletin No. 206. Price, As. 3 or 4d.	Ditto . . .	Ditto.
253	The Preparation in the Home of Infant and Invalid foods from <i>Cholam</i> . (English, Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 61.	M. Suryanarayana . . .	Government Press, Madras.
254	Home-made Malt Foods from Great Millet (<i>Andropogon Sorghum</i>). (English, Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 62.	B. Viswanath . . .	Ditto.
255	Conversion of Prickly Pear into Manure. (English, Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 63.	Ditto . . .	Ditto.
256	Soils of the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 160 of 1929. Price, As. 7.	D. L. Sahasrabudhe . . .	Government Central Press, Bombay.
257	Periodicity of the Nitrate Contents of Soils. (Reprinted from 'Soil Science,' Vol. XXXIX, No. 3, March, 1930.)	H. N. Batham and L. S. Nigam.	Government Press, Allaha- bad.

BOTANY.

258	Studies in Inheritance in cotton. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. 4. Price, As. 14 or 1s. 6d.	Mohammad Afzal . . .	Government of India Central Publication Branch, Calcutta.
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List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
BOTANY—contd.			
259	Cotton Growing in India in relation to climate. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. 5. Price, As. 12 or 1s. 3d.	Trevor Trought and Mohammad Aizal.	Government of India Central Publication Branch, Calcutta.
260	Effect of some Meteorological conditions on the Growth of Punjab American Cotton. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. 6. Price, As. 7 or 9d.	Trevor Trought . . .	Ditto.
261	The Calculation of Linkage Values. A Comparison of various Methods. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 1. Price, Re. 1 or 1s. 6d.	Mahbub Alam . . .	Ditto.
262	Root Development of Rice under Different Conditions of Growth. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 2. Price, As. 14 or 1s. 6d.	R. L. Sethi . . .	Ditto.
263	Studies in Indian Oil Seeds, No. 3, ' <i>Carthamus tinctorius</i> Linn.' The Types of Safflower. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 3. Price, As. 4 or 5d.	Abdur Rahman Khan . . .	Ditto.
264	Studies in Gujarat Tobaccos and their Improvement. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 4. Price, As. 12 or 1s. 3d.	V. M. Majumdar . . .	Ditto.
265	Studies in Indian Oil Seeds, No. 4. The Types of <i>Sesamum indicum</i> . Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 5. Price, Re. 1-8-0 or 2s. 6d.	Kashi Ram . . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
BOTANY—concl'd.			
266	Classification and Study of the characters of the cultivated Rices in the United Provinces. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 6. Price, Re. 1-10 or 2s. 6d.	R. L. Sethi and Baijanti Prosad Saxena.	Government of India Central Publication Branch, Calcutta.
267	The Inheritance of Characters in Rice, Part III. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 7. Price, As. 14 or 1s. 6d.	K. Ramiah	Ditto.
268	The Inheritance of Characters in Rice, Part IV. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 8. Price, Re. 1-0 or 2s. 3d.	K. Raminh, S. Jobithraj and S. Dharmalinga Mudaliar.	Ditto.
269	Studies in <i>Cajanus indicus</i> . Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XIX, No. 1. Price, Re. 1-14 or 3s. 3d.	D. N. Mahta and B. B. Dave.	Ditto.
270	Studies in Indian Pulses, (2) Some varieties of Indian Gram (<i>Cicer arietinum</i> Linn.). Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XIX, No. 2. Price, Re. 1-12 or 3s.	F. J. F. Shaw and Abdur Rahman Khan.	Ditto.
271	List of Publications on the Botany of Indian Crops. Pusa Bulletin No. 202. Price, Rs. 3-8 or 6s.	Compiled by F. J. F. Shaw and Rakhal Das Bose.	Ditto.
272	The Grain Shedding Character in Rice Plants and its Importance. Pusa Bulletin No. 205. Price, As. 12 or 1s. 3d.	S. G. Bhalerao	Ditto.

MYCOLOGY.

273	Cotton Wilt. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. 3. Price, Re. 1-4 or 2s. 3d.	Johangir Fardunji Dastur	Government of India Central Publication Branch, Calcutta.
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List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
MYCOLOGY—contd.			
274	A Leaf-spot disease of <i>Andropogon Sorghum</i> caused by <i>Ocerospora Sorghi</i> E. & E. Memoirs of the Department of Agriculture in India, Botanical Series. Vol. XVIII, No. 9. Price, As. 10 or 1s.	T. S. Ramakrishnan	Government of India Central Publication Branch, Calcutta.
275	<i>Sorosporium Paspali</i> McAlp. on <i>Paspalum scrobiculatum</i> L., Kodra Smut. Pusa Bulletin No. 201. Price, As. 8 or 10d.	Abdus Sattar	Ditto.
276	Red-rot disease of sugarcane. Madras Department of Agriculture Leaflet No. 30. (English, Tamil, Telugu, Kanarese and Malayalam.)	S. Sundararaman	Government Press, Madras.
277	The Mosaic disease of sugarcane. Madras Department of Agriculture Leaflet No. 31. (English, Tamil, Telugu, Kanarese and Malayalam.)	Ditto	Ditto.
278	Cocconut Stem bleeding disease. Madras Department of Agriculture Leaflet No. 32.	Ditto	Ditto.
279	Sprayers and Spraying. Madras Department of Agriculture Leaflet No. 34. (English, Tamil, Telugu, Malayalam and Kanarese.)	Ditto	Ditto.
280	Bad-rot palmyras. Madras Department of Agriculture Leaflet No. 36. (English, Tamil, Telugu, Malayalam and Kanarese.)	Ditto	Ditto.
281	Powdery mildew of the grape and its control in Bombay. Bombay Department of Agriculture Bulletin No. 163 of 1930. Price, As. 3.	B. N. Uppal, G. S. Cheema and M. Kamat.	Government Central Press, Bombay.
282	Betelvine disease. Bengal Department of Agriculture Leaflet No. 5 of 1930. (English and Bengali.)	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
283	Root-rot of Paddy. Bengal Department of Agriculture, Leaflet No. 8 of 1930. (English and Bengali.)	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
MYCOLOGY—concd.			
284	Ufra disease in Paddy (Bongali). Leaflet No. 2 of 1931 of the Department of Agriculture Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
285	Spraying of Betelvines (English and Bongali). Leaflet No. 5 of 1931 of the Department of Agriculture, Bengal.	Ditto . .	Ditto.
286	The Early Blight of Potatoes and its Control. Punjab Department of Agriculture, Leaflet No. 83.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
287	Grain Smut of <i>Jowar</i> and its Prevention. Punjab Department of Agriculture Leaflet No. 85.	Ditto . .	Ditto.
288	Seasonal Periodicity of Coffee Leaf Disease (<i>Hemelia Vastaria</i> , B. and Br.) Mysore Coffee Experiment Station, Bulletin No. 4.	Issued by the Department of Agriculture in Mysore.	Government Press, Bangalore.

ENTOMOLOGY.

289	A condition towards our knowledge of the Aleyrodidae (White Flies) of India. A new Coccid injurious to Fruit Trees in Baluchistan. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. XII, Nos. 1 and 2. Price, Rs. 3-2 or 5s. 6d.	Karam Singh and F. Laing.	Government of India Central Publication Branch, Calcutta.
290	Carabidae. Catalogue of Indian Insects, Part 18. Price, Rs. 8-10 or 14s. 6d.	H. E. Andrews . .	Ditto.
291	Gyrinoidea. Catalogue of Indian Insects, Part 19. Price, Rs. 12 or 1s. 3d.	George Ochs . . .	Ditto.
292	A contribution to our knowledge of south Indian Coccidae. Pusa Bulletin No. 197. Price, Rs. 2-12 or 5s.	T. V. Ramakrishna Ayyar	Ditto.
293	List of Publications on Indian Entomology, 1928. Pusa Bulletin No. 200. Price, Rs. 7 or 9d.	Compiled by the Imperial Entomologist, Pusa.	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
ENTOMOLOGY—contd.			
294	List of Publications on Indian Entomology, 1929. Pusa Bulletin No. 207. Price, Rs. 10 or 1s.	Compiled by the Imperial Entomologist Pusa.	Government of India Central Publication Branch, Calcutta.
295	Red Hairy Caterpillar Pest. (English, Tamil, Telugu and Malayalam.) Madras Department of Agriculture Leaflet No. 2 (Revised).	Y. Ramachandran Rao.	Government Press, Madras.
296	Army Worm of Paddy. Madras Department of Agriculture Leaflet No. 14. (English, Tamil, Telugu, Kanarese and Malayalam.) Free.	Ditto . . .	Ditto.
297	Prickly pear cochineal. Madras Department of Agriculture Leaflet No. 35. (English, Tamil, Telugu, Malayalam and Kanarese.) Free.	T. V. Ramakrishna Ayyar	Ditto.
298	How to Control the Jasmine Bug (English, Tamil, Telugu and Kanarese). Madras Department of Agriculture Leaflet No. 66. Free.	Y. Ramachandra Rao . .	Ditto.
299	Hairy Caterpillar Pest on Dry Crops. (English, Tamil and Telugu.) Madras Department of Agriculture pamphlet.	Issued by the Department of Agriculture, Madras.	Ditto.
300	Mango-hoppers and mildew and their control. Bombay Department of Agriculture Leaflet No. 6 of 1930. (With vernacular versions.)	Issued by the Department of Agriculture, Bombay.	Government Printing and Stationery, Bombay.
301	Destruction of rice grass-hoppers. Bombay Department of Agriculture Leaflet No. 7 of 1930.	Ditto . . .	Ditto.
302	Control of the red pumpkin beetle. Bombay Department of Agriculture Leaflet No. 9 of 1930.	Ditto . . .	Ditto.
303	Insects and general control of Insect Pests. Bengal Department of Agriculture Bulletin No. 3 of 1929.	Issued by the Department of Agriculture, Bengal.	Sreenath Press, Dacca.
304	Rice Hispa (Bengaloe). Bengal Department of Agriculture Leaflet No. 1 of 1930.	Ditto . . .	Bengal Secretariat Book Depot, Calcutta.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
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ENTOMOLOGY—*concd.*

305	On Maize and Jowar Borers and their control. Punjab Department of Agriculture Leaflet No. 82.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
306	San Jose Scale (<i>Comstockaspis perniciosus</i> , Comst.) and its control. Punjab Department of Agriculture Leaflet No. 88.	Ditto . . .	Ditto.
307	The Sugarcane Leaf-hopper (<i>Pyrilla</i> spp.) and its control. Punjab Department of Agriculture Leaflet No. 89.	Ditto . . .	Ditto. ³
308	Pamphlet on "Methods for the control of locusts" published by the Imperial Council of Agricultural Research (in Gurukhi).	Ditto . . .	Ditto.
309	A Leaflet on Common Insecticides and their uses.	Issued by the Department of Agriculture, Central Provinces.	C. P. Government Printing, Nagpur.
310	Common Insecticides and their control. Leaflet of the Department of Agriculture, Central Provinces. (Hindi and Marathi.)	Ditto . . .	Ditto.
311	Instructions for control of Locusts. Leaflet of the Department of Agriculture, Central Provinces. (Hindi and Marathi.)	Ditto . . .	Ditto.
312	The Coffee Berry Borer (<i>Stephanoderes hampei</i>), a preliminary account (English and Kannada). Mysore Coffee Experiment Station Bulletin No. 2.	Issued by the Director of Agriculture in Mysore.	Government Press, Bangalore.

BACTERIOLOGY.

313	The Influence of Exchangeable Ions in Soil Colloids on Bacterial Activity and Plant Growth. Memoirs of the Department of Agriculture in India, Bacteriological Series, Vol. II, No. 4. Price, As. 7 or 9d.	N. V. Joshi and A. N. Puri.	Government of India Central Publication Branch, Calcutta.
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List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
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BACTERIOLOGY—contd.

314	A Method of Increasing the Manurial Value of Bone Phosphate. Pusa Bulletin No. 204. Price, As. 8 or 10d.	N. D. Vyas . . .	Government of India Central Publication Branch, Calcutta.
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ANIMAL HUSBANDRY AND DAIRYING.

315	The <i>Journal of the Central Bureau for Animal Husbandry and Dairying in India</i> , Vol. III, Parts III and IV. Vol. IV, Parts I, II, III and IV. Price, As. 10 per part. Annual subscription, Rs. 2-8.	Issued under the authority of the Imperial Council of Agricultural Research.	Government of India Central Publication Branch, Calcutta.
316	Breeding and Rearing of Cattle and Buffaloes (Revised). (Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 31.	R. W. Littlewood . .	Government Press, Madras.
317	Notes on Ensilage (Revised). (Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 43.	Ditto . . .	Ditto.
318	Conditions to be fulfilled for the Grant of Government Premia for Breeding Bulls maintained by Private Bodies (Revised).	Ditto . . .	Ditto.
319	Rations of Milch cows, Dry cows and calves. Reprint (English, Tamil, Telugu, Kanarese and Malayalam). Madras Department of Agriculture, Leaflet No. 60. Free.	Ditto . . .	Ditto.
320	Broad Hints for everyday use, No. II. Feed your cow. (English, Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 70. Free.	Ditto . . .	Ditto.
321	Note on the Cultivation and Management of Grassland at the Hosur Live-stock Station, Madras. Madras Department of Agriculture, Pamphlet No. 1.	Ditto . . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
ANIMAL HUSBANDRY AND DAIRYING—contd.			
322	<i>Ragi Silago in Coimbatore District. Madras Department of Agriculture Notes No. 5. (English and Tamil.)</i>	K. Gopala Krishna Raju	Government Press, Madras.
323	<i>Cattle Feeds of Western India. Bombay Department of Agriculture Bulletin No. 161 of 1930. Price, A. 1.</i>	D. L. Sahasrabudhe	Government Central Press, Bombay.
324	<i>Ensilago or Silago in Bengal. Bengal Department of Agriculture Leaflet No. 3 of 1930.</i>	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
325	<i>Fodder Grass (English and Bengalee). Bengal Department of Agriculture Leaflet No. 4 of 1930.</i>	Ditto	Ditto.
326	<i>List of Horse and Cattle Fairs and Shows in the Punjab and Punjab States during 1929-30.</i>	Issued by the Director of Veterinary Services, Punjab, Lahore.	Government Printing, Lahore.
327	<i>Sheep Breeding. Punjab Veterinary Department Leaflet No. 4.</i>	Ditto	Ditto.
328	<i>The Table of Poultry Industry. Punjab Department of Agriculture Leaflet No. 87.</i>	Issued by the Department of Agriculture, Punjab.	Ditto.
329	<i>Banikhot Disease of Fowls. Punjab Department of Agriculture Leaflet No. 93.</i>	Ditto	Ditto.
330	<i>Suggested Rations for Municipal Flocks, etc., in Bihar and Orissa. Bihar and Orissa Department of Agriculture Leaflet No. 2 of 1930.</i>	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing Bihar and Orissa, Gularbagh.
331	<i>Report on the Cattle Breeding Operations in the Central Provinces and Berar for the year ending 31st March 1929. Price Re. 1.</i>	Issued by the Department of Agriculture, Central Provinces.	Central Provinces Government Printing, Nagpur.
332	<i>Report on the Cattle Breeding Operations in the Central Provinces and Berar for the year ending 31st March 1930. Price, Re. 1.</i>	Ditto	Ditto.

344 AGRICULTURAL OPERATIONS IN INDIA, 1929-30 AND 1930-31

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
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ANIMAL HUSBANDRY AND DAIRYING—*concl'd.*

333	Summary of the Conclusions and Recommendations of the Royal Commission on Agriculture in India with regard to Cattle (Assamese and Bengali). Assam Department of Agriculture, Leaflet No. 3 of 1929.	Issued by the Department of Agriculture, Assam.	Government Press, Assam, Shillong.
334	Suggestions for improving the Health of Cattle in Assam. Leaflet No. 1 of 1931 of the Department of Agriculture, Assam.	Ditto . . .	Ditto.

VETERINARY.

335	<i>The Indian Journal of Veterinary Science and Animal Husbandry</i> , Vol. I, Parts I and II. Annual subscription, Rs. 5 or 8s. 3d.	Issued under the authority of the Imperial Council of Agricultural Research.	Government of India Central Publication Branch, Calcutta.
336	<i>The Indian Veterinary Journal</i> (The Journal of the All-India Veterinary Association). Quarterly. Annual subscription, Rs. 4 or 6s. 6d. for members and students, Rs. 8 or 10s. for others.	P. Srinivasa Rao . . .	Peoples' Printing and Publishing House Ltd., Triplicane, Madras.
337	Annual Report of the Imperial Institute of Veterinary Research, Muktesar, for the year ending 31st March 1929. Price, Re. 1-4 or 2s.	Issued by the Director, I. I. V. R., Muktesar.	Government of India Central Publication Branch, Calcutta.
338	Annual Report of the Imperial Institute of Veterinary Research, Muktesar, for the year ending 31st March 1930. Price, Re. 1-6 or 2s. 3d.	Ditto . . .	Ditto.
339	The Problems of Rinderpest in India. Pusa Bulletin No. 199. Price, Re. 1-4 or 2s. 3d.	J. T. Edwards . . .	Ditto.
340	The Description of a New Fluke found in the House Crow (<i>Corvus splendens</i>). Pusa Bulletin No. 203.	V. R. Phadke and Amar Nath Gulati.	Ditto.
341	Annual Administration Report of the Madras Civil Veterinary Department for the year 1929-30.	Issued by the Director of Veterinary Services, Madras.	Government Press, Madras.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
VETERINARY—contd.			
342	Annual Administration Report of the Madras Civil Veterinary Department for the year 1929-30. Price, Re. 1.	Issued by the Director of Veterinary Services, Madras.	Government Press, Madras.
343	Scientific Papers of the Civil Veterinary Department, Madras, Vol. I.	Ditto . .	Ditto.
344	Annual Administration Report of the Bombay Veterinary College, Bombay City and Harbour Veterinary Department and Civil Veterinary Department in the Bombay Presidency (including Sind) for the year 1928-29. Price, As. 3 or 4d.	Issued by the Principal, Bombay Veterinary College, Superintendent, Civil Veterinary Department, Bombay Presidency, Poona, Superintendent, C. V. D., Sind and Rajputana.	Government Central Press, Bombay.
345	Annual Administration Report of the Bombay Veterinary College, Bombay City and Harbour Veterinary Department and Civil Veterinary Department in the Bombay Presidency (including Sind) for the year 1929-30. Price, As. 4 or 5d.	Ditto . .	Ditto.
346	Annual Reports of Civil Veterinary Department and Bengal Veterinary College for 1928-29. Price, Re. 1-4 or 2s.	Director and Veterinary Adviser to Government of Bengal.	Bengal Secretariat Book Depot, Calcutta.
347	Annual Reports of Civil Veterinary Department and Bengal Veterinary College for 1929-30. Price, Re. 1-4 or 2s.	Ditto . .	Ditto.
348	Care and management of cattle in Bengal. (Translation in Bengali of the English pamphlet.)	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Calcutta.
349	Annual Report of the Civil Veterinary Department, United Provinces, for the year 1928-29. Price, Re. 1-12.	Director, Civil Veterinary Department, United Provinces.	Printing and Stationery, United Provinces.
350	Annual Report of the Civil Veterinary Department, United Provinces, for the year 1929-30. Price, Rs. 2.	Ditto . .	Ditto.

346 AGRICULTURAL OPERATIONS IN INDIA, 1929-30 AND 1930-31

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
VETERINARY—contd.			
351	Annual Report of the Civil Veterinary Department, Punjab, for the year 1928-29.	Issued by the Director, Veterinary Services, Punjab.	Government Punjab. Printing,
352	Annual Report of the Civil Veterinary Department, Punjab, for the year 1929-30. Price, Rs. 3 or 4s. 6d.	Ditto . .	Ditto.
353	List of Horses and Cattle Fairs and Shows in the Punjab and Punjab States during the year 1930-31.	Ditto . .	Ditto.
354	On Rinderpest. Punjab Veterinary Department Leaflet No. 1.	Ditto . .	Ditto.
355	On Haemorrhagic Septicaemia. Punjab Veterinary Department Leaflet No. 2.	Ditto . .	Ditto.
356	On Foot-and-Mouth Disease. Punjab Veterinary Department Leaflet No. 3.	Ditto . .	Ditto.
357	Report on the Civil Veterinary Department, Burma (including the Insein Veterinary School), for the year ended the 31st March 1929. Price, Rs. 1-4 or 1s. 11d.	Issued by the Director, Veterinary Services, Burma.	Government Rangoon. Press,
358	Report on the Civil Veterinary Department, Burma (including the Insein Veterinary School), for the year ended 31st March 1930. Price, Rs. 2 or 3s.	Ditto . .	Ditto.
359	Interim Report on the Immunization of Draft Animals in Burma against Anthrax.	Ditto . .	Ditto.
360	Parasitic Worms of Domestic Animals. Burma Veterinary Department Bulletin No. 7 of 1928 (Burmese).	Ditto . .	Ditto.
361	Instruction for the inoculation of animals with serum virus or Vaccine and notes on the care, handling and sterilization of hypodermic syringes. Burma Veterinary Department Pamphlet No. 1 of 1930.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1929-31—concl'd.

No.	Title	Author	Where published
VETERINARY—concl'd.			
362	Instructions for the use of Anthrax Vaccine. Burma Veterinary Department Leaflet No. 1 of 1930.	Issued by the Director, Veterinary Services, Burma.	Government Press, Rangoon.
363	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for the year 1928-29. Price, Re. 1.	Director, Civil Veterinary Department, Bihar and Orissa.	Government Press, Bihar and Orissa, Gulzarbagh.
364	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for the year 1929-30. Price, Re. 1.	Ditto . .	Ditto.
365	Report of the Civil Veterinary Department, Assam, for the year 1928-29. Price, As. 5 or 5d.	Superintendent, Civil Veterinary Department, Assam.	Government Press, Shillong.
366	Report of the Civil Veterinary Department, Assam, for the year 1929-30. Price, As. 5 or 6d.	Ditto . .	Ditto.
367	Report of the Civil Veterinary Department, North-West Frontier Province, for the year 1928-29. Price, Re. 1-13 or 3s. 3d.	Superintendent, Civil Veterinary Department, North-West Frontier Province.	Manager, Government Printing and Stationery, North-West Frontier Province, Peshawar.
368	Report of the Civil Veterinary Department, North-West Frontier Province, for the year 1929-30. Price, Re. 1-11 or 3s.	Ditto . .	Ditto.

<p>PUNJAB.</p> <p>1. Raselewnla.</p> <p>CENTRAL PROVINCES.</p> <p>1. Akola.</p>	<p>BIHAR AND ORISSA.</p> <p>1. Kanku.</p> <p>2. Gaya.</p> <p>3. Sepeya.</p> <p>4. Cutlack.</p> <p>CENTRAL PROVINCES.</p> <p>1. Raipur.</p> <p>2. Powarkhera.</p> <p>3. Adhartal.</p> <p>4. Nagpur.</p> <p>ASSAM.</p> <p>1. Karimganj.</p> <p>2. Upper Shillong.</p> <p>3. Titabor.</p> <p>N.-V. E. PROVINCE.</p> <p>1. Ternab</p>	<p>14. Pabng.</p> <p>15. Dianbarl.</p> <p>16. Boga.</p> <p>17. Jamalpur.</p> <p>18. Ramgaur.</p> <p>19. Malda.</p> <p>20. Dinajpur.</p> <p>21. Malanguri.</p> <p>UNITED PROVINCES.</p> <p>1. Benares.</p> <p>2. Fyzabad.</p> <p>3. Mawab.</p> <p>4. Malapuri.</p> <p>5. Mehpuri.</p> <p>6. Jachonda.</p> <p>7. Hardoi.</p> <p>8. Bahvalch.</p> <p>9. Bulandshahr.</p> <p>10. Jaitpur.</p> <p>11. Badam.</p> <p>12. Nagina.</p> <p>13. Navabganj.</p> <p>14. Meerut.</p> <p>15. Atarra.</p> <p>PUNJAB.</p> <p>1. Gurgaon.</p> <p>2. Rohtak.</p> <p>3. Karnal.</p> <p>4. Ambala.</p> <p>5. Jodhpura.</p> <p>6. Jullundar.</p> <p>7. Beas.</p> <p>8. Kangra.</p> <p>9. Ferozepur.</p> <p>10. Gujranwala.</p> <p>11. Gujrat.</p> <p>12. Jhang.</p> <p>13. Dera Ghazi Khan.</p> <p>14. Mansell.</p> <p>15. Campbellpur.</p> <p>BUNYA.</p> <p>1. Padu.</p> <p>2. Pankhaung.</p> <p>3. Si-ahng.</p> <p>4. Kyaukpya.</p> <p>BIHAR AND ORISSA.</p> <p>1. Balasore.</p> <p>2. Asandpur.</p> <p>3. Puri.</p> <p>4. Khurda.</p> <p>5. Angul.</p>
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Key to the Diagrammatic Map of Agricultural Stations—contd.

Research Institutes and Agricultural Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding Farms	Subsidiary Cattle-breeding Farms
HYDERABAD. 1. Himayat Sagar. 2. Farbhani.	HYDERABAD STATE. 1. Nizamnagar.	HYDERABAD STATE. 1. Sangareddy. 2. Alir. 3. Mahbubnagar.	BHAR AND MISRA— 6. Purulia. 7. Ramnath. 8. Neterhat. 9. Nawadah. 10. Janul. 11. Banka. 12. Darbhanga. 13. Sivan. 14. Mkranganj. 15. Sela. 16. Chhanki. 17. Chhabasa. 18. Sambaiput.			
MYSORE STATE. 1. Bangalore.	TRAVANCORE STATE. 1. Porakad.	MYSORE STATE. 1. Hebbal. 2. Nagenhalli. 3. Hanur. 4. Marthur. 5. Balechannur. 6. Bhubur. 7. Yelachhalli.	CENTRAL PROVINCES. 1. Chhindwara. 2. Tharsa.		HYDERABAD STATE. 1. Hyderabad.	
TRAVANCORE STATE. 1. Quilon.	NON-OFFICIAL. Moppy U. P. A. S. I.). Permade (Travancore—U. P. A. S. I.). Anelkulam (Travancore—U. P. A. S. I.). Tennimal (Travancore—U. P. A. S. I.).	BARODA STATE. 1. Baroda. 2. Jagudan. 3. Amrell.	N.W. F. PROVINCE. 1. Haripur. 2. Faridkot.		MYSORE STATE. 1. Parvatharayankere.	
BHOPAL STATE. 1. Nadi Bagh.			TRAVANCORE STATE. 1. Alwaye. 2. Oachira. 3. Vakkom. 4. Kottarakara. 5. Eranlel. 6. Pallyara. 7. Cape Comorin.		TRAVANCORE STATE. 1. Tivrandrum. 2. Eranthimankalam.	
PATIALA STATE. 1. Patiala.			NON-OFFICIAL. Bordighatta (Assam—Indian Ten Association).			
NON-OFFICIAL. Indore (Central India—Institute of Plant Industry). Ranchi (Bihar and Orissa—Lae Research Institute). Tocklai (Assam—Indian Ten Association).		TRAVANCORE STATE. 1. Alleppey. 2. Kozh. 3. Nagercoil. NON-OFFICIAL. Siddapur (Madras—U. P. A. S. I.).				

